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THE SPONTANEOUS GENERATION THEORY, AND ITS RELATION TO THE GENERAL THEORY OF EVOLUTION.

ANNUAL ADDRESS OF THE PRESIDENT, CHARLES F. COX.

(*Read January 4th*, 1889.)

It has been the privilege of our generation to witness another Renaissance. From a deadly subserviency to dogmatic authority, the human intellect—this time in the domain of natural science—has arisen to a new dispensation of freedom. Like the literary and artistic revival of the fifteenth century, the present awakening is accompanied by a reformation of ethics and philosophy, and by an earnest search for a sure and substantial basis of truth. It is not to be presumed that in this case, any more than in the former, the ultimate foundations of all thought have been laid: but at least there has been established a safe basis upon which to erect a new wing of the great temple of knowledge. The structure will of course be enlarged by generations yet to come, and doubtless future architects will even modify and improve the design of what is now building; nevertheless I think we may feel assured that the work we see going on is accomplishing results which, in the main, will prove to be satisfactory and permanent.

The part which the followers of Darwin and Spencer are contributing to this magnificent embodiment of scientific learning certainly displays in itself attractive symmetry and consistency, which appeal strongly to our æsthetic sense of proportion and grace, but which, we must confess, somewhat prepossess us in its favor without regard to the question of its relative fitness or

harmony with other portions of the general scheme. Yet it is pleasant to find that, as the walls gradually rise, the separate blocks fit readily into their places, and that there develops a greater continuity of pattern and a stricter unity of meaning, than a casual survey of the constituent members would have led one to anticipate. Indeed, the intelligent and careful observer is constantly filled with delighted surprise at the wonderful way in which one part reinforces and complements another; but, in the satisfaction which he feels with these larger agreements and harmonies, he is apt to overlook for the moment the slighter incongruities,—the points where trimming and fitting are still required, or where possibly an entire rearrangement will finally have to be made.

He is not necessarily an unfriendly critic, who points out imperfections in a plan. Of a scientific or philosophic system particularly, he is often the strongest advocate, who most candidly admits the inadequacy of his theory in its weaker links, and invites suggestion from any honest quarter as to how the chain may be most effectively strengthened. One of the characteristics of the late Charles Darwin, which commended both him and his doctrine to favorable consideration, was the absolute ingenuousness with which he recognized and indicated the directions in which his own labors had proved inconclusive; and I venture to say that one of the most powerful factors contributing to the rapid acceptance of his theory of Natural Selection, was the evident sincerity with which he invited just criticism, and the perfect simplicity with which he relinquished beliefs in face of convincing evidence, and modified his views to every new gleam of truth. So far was it from being a confession of weakness,—it was the strongest testimony he could give to his abiding faith in the correctness of his fundamental principles. He knew that his building stood upon a solid base. Why, then, should his equanimity be disturbed by minor changes in the superstructure? Or why should any man entertain pride of opinion concerning an eternal verity!

There is no scheme of truth that is perfect. If it were so, truth-seeking would end. This cannot be unless man becomes omniscient. Meanwhile, one philosophical system must supersede another in endless succession,—each one a product of evolution out of all that have preceded. Truth, nevertheless, is

eternal. Like the human body, it may rearrange its component units and renew its ever-perishing tissues, but there will remain always an ultimate framework of formed material, to which cling permanent characteristics and a changeless individuality.

The theory of Evolution is no exception to the general rule, as to the incompleteness and mutability of all human attempts at a system of universal knowledge. In fact, it is itself a development—what we know as Evolution to-day being the descendant of a long line of constantly varying ancestors, reaching back at least to the time of Plato and Aristotle, and perhaps we may say even to the earliest appearance of anything like a philosophic idea in the mind of the first thinking man. So obvious is the fact of unfolding growth that, as soon as the human intellect was directed to the actual study of organic forms, it must have begun trying to account for those forms, by some sort of a theory of derivation. Probably the first real reasoning that man did was inductive, and it is likely that some rude kind of cosmology preceded any distinct notion of cosmogony. Perhaps the original basis of all thought on the subject was a rough comparison, such as a primitive Arab might make, who, having been accustomed to the dromedary with one hump, should make the acquaintance of the Bactrian camel with two humps. It seems as if even Adam must have had his attention arrested by such slight differences as this in the animals around him, particularly when, as it is said, they passed before him to be named. For naming is the mother of classification, and classification means first comparison and then separation.

From the examination and contemplation of things immediately about it, the human mind intuitively and inevitably reached out for a theory that would explain also the more remote portions of the cosmos, which it but dimly perceived and, at first, but vaguely wondered at. Almost the earliest man began groping for a universal law,—a general formative principle. The search at last resulted in something like a coherent conception of the origin and development of things, which was formulated by the early Greek philosophers and physicists, and which, with many mere variations and occasional specific modifications, has come down to us through Aristotle, Lucretius, Descartes, Lamarck, Erasmus Darwin, Charles Darwin, Wallace, and Spencer.

For convenience in naming, we have been accustomed to consider all material things as disposed upon distinctly separated planes, placed one above another, like steps, thus marked off into kingdoms (1) of the Elements, (2) of Chemical Compounds, including Minerals, (3) of Plants, and (4) of Animals. In the vegetable and animal kingdoms we have followed Linnæus, in regarding the inhabitants as gathered together in strictly bounded groups of various degrees of importance, from sub-kingdoms down to species. And although this has been known as the "natural system," it is now very plain that it is entirely artificial. The fact is that there are no clearly marked classes in animate nature, but that what we choose to call kingdoms, families, orders, genera, and species, shade off imperceptibly into one another, in continuous succession, from the protoplasm-speck upwards; so that, instead of planes widely divided by steps, and groups upon these planes rigidly fenced off from one another, a gently sloping hill-side closely covered with every possible form,—the simplest at the bottom, the most complex, or most highly differentiated, at the top,—a perfect spectrum of the whole living creation, displayed in gradually blending chromatic bands from the base to the apex, and spreading laterally in infinite variety of combinations and interweavings, would probably more nearly represent the system of Development as seen in the light of the latest science. According to the present theory of evolution, some such figure as I have just used would roughly depict not only the relations of all material things as now existing, but also the relations of things as they have existed at any one point of time in the past, or as they may possibly exist at any period in the future. Moreover, it would in a general way picture the relations of the whole succession of substances and organisms from the beginning of time to the end. According to this hypothesis, if we but knew just how to follow the clews, we could trace a more or less irregular line from any one form to any other we might select; since it assumes a consistent and continuous genealogical warp, underlying what at first sight appears to be a wholly incongruous pattern.

It therefore results that, while we can point here and say these are animals, and there and say those are plants, we cannot with certainty indicate a line absolutely separating all animals from all plants, or all animal characteristics from all plant character-

istics. The same impossibility exists as to dividing all organic substances from all inorganic, all classes of vegetables from all other classes, and all groups of similar animals from all other groups of animals.

These and other like facts compose the foundation of the Evolution Hypothesis of to-day, of which the Lamarckian theory of Descent with Variation is one story, and the Darwinian doctrine of Natural Selection is another. Perhaps Herbert Spencer's extension of the principle of Derivation to the entire range of material things,—to the inorganic and the organic worlds alike,—may be regarded as the pediment and roof, capping and closing over the whole structure.

Now, every hypothesis is capable of being submitted to a certain order of proof, and modern systems of logic provide us with perfectly trustworthy criteria of the value of such proof. Still, all inductive processes lead ultimately only to varying degrees of probability. Absolute certainty seems to be an absolute impossibility. Fortunately, however, we are able to support some propositions with such an overwhelming accumulation of evidence that no one can rationally gainsay them. But other affirmations may never be placed beyond the possibility of question, because anything like sufficient proof of their truth or falseness is, in the nature of the case, inaccessible. Between these two extremes there is every grade of fact and faith.

Whether the evolution hypothesis is to any particular mind a rational explanation of the existence and order of the universe or not, depends upon what amount of probability that mind deems necessary as a basis of faith, or what kind of evidence it considers applicable to the matter. Some persons thought the doctrine of derivation was satisfactorily established, as regards organic forms, as soon as it became tolerably clear that it was not absolutely incompatible with any series of known facts in the animal and plant worlds. On the other hand, some insisted that it should be shown to be positively and exclusively consonant with every known fact. There are intelligent people who still stand upon this narrow ground. Many scientific men were convinced that Natural Selection was a *vera causa* applicable to all biological problems, as soon as Darwin set forth what experimental verification he had derived from a study of *artificial selection*. But others proposed further experiments, every one of which seemed to its advocate to be a crucial test.

Professor Huxley is one of those whose minds had what may. without disparagement, be termed a natural bias towards the whole philosophy of mechanical causation, or *monism*, as Professor Haeckel calls it; and yet he felt very strongly the inadequacy of Darwin's experimental evidence at one point. On this subject he has said:—"There is, in fact, one set of * * * peculiarities which the theory of selective modification, as it stands at present, is not wholly competent to explain, and that is the group of phenomena which I mentioned to you under the name of Hybridism, and which I explained to consist in the sterility of the offspring of certain species when crossed one with another. It matters not one whit whether this sterility is universal, or whether it exists only in a single case. Every hypothesis is bound to explain, or, at any rate, not be inconsistent with, the whole of the facts which it professes to account for ; and if there is a single one of these facts which can be shown to be inconsistent with (I do not merely mean inexplicable by, but contrary to) the hypothesis, the hypothesis falls to the ground,—it is worth nothing, One fact with which it is positively inconsistent is worth as much, and is as powerful in negativing the hypothesis, as five hundred. If I am right in thus defining the obligations of a hypothesis, Mr. Darwin, in order to place his views beyond the reach of all possible assault, ought to be able to demonstrate the possibility of developing, from a particular stock by selective breeding, two forms, which should either be unable to cross one with another, or whose cross-bred offspring should be infertile with one another. For, you see, if you have not done that you have not strictly fulfilled all the conditions of the problem ; you have not shown that you can produce, by the cause assumed, all the phenomena which you have in nature. Here are the phenomena of Hybridism staring you in the face, and you cannot say, 'I can by selective modification, produce these same results. Now, it is admitted on all hands that, at present, so far as experiments have gone, it has not been found possible to produce this complete physiological divergence by selective breeding. * * * If it could be proved, not only that this *has* not been done, but that it *cannot* be done; if it could be demonstrated that it is impossible to breed selectively, from any stock, a form which shall not breed with another, produced from the same stock ; and if we were shown that this must be

the necessary and inevitable result of all experiments, I hold that Mr. Darwin's hypothesis would be utterly shattered."

Of course, after making this very frank avowal, Professor Huxley went on to say that the fatal negative evidence referred to had not been produced and that, for his part, he saw reason to believe that the much-desired positive evidence on the other side would some day be forthcoming ; so that he was able to maintain his faith in the Darwinian theory of the origin of species, although evidently he could not at that time have looked upon it as entirely beyond doubt. But that, I believe, was twelve or fifteen years ago, and I think that since Professor Marsh made his discoveries of Orohippus and other fossil-horses, and the equally important Odontornithes, Professor Huxley has considered that all really necessary "links" heretofore missing have been supplied, and that he has declared the evolution theory to stand upon as complete and secure a foundation as the Copernican theory of the motions of the heavenly bodies; so that the problem of hybridism no longer has the place in his mind that it occupied before the confirmatory evidence just spoken of had been obtained.

All this goes to show that to a logical mind like Professor Huxley's no hypothesis is entirely satisfactory as long as it seems likely to remain an hypothesis, and that such a mind, if it is interested in the subject at all, naturally seeks for an assurance that the theory is, as Mill says, "of such a nature as to be either proved or disproved by comparison with observed facts."

Professor Haeckel is not as logical as Professor Huxley, and therefore to the former a point is proven by much less evidence than is necessary to completely convince the latter. Haeckel never attached any importance to the doubts about hybridism, which at one time so much troubled Huxley, but has asserted from the beginning that artificial selection can produce, and has produced, genuinely new species.

In view of the existence of these widely differing estimates of the quality and quantity of proof required to establish the doctrine of descent and the principle of natural selection, it is almost unnecessary to say that there is at least equal divergence of opinion as to the evidence needed to place the general theory of evolution upon an unassailable logical basis ; for the longer the line of works, the more weak points will it present to the enemy.

I think it will be admitted that the evolution hypothesis is under obligation to do more than merely cohere in itself, and harmonize with the state of things it is intended to explain. If it is to pass beyond the stage of hypothesis into that of law, it must, sooner or later, establish itself upon ground that will exclude the application of any other theory to the same class of facts. In substantiation of it we must exhaust whatever resources of verification are at our command, and, so far as we assign a cause or causes within the range of experimental science, we should not rest satisfied until, as Professor Huxley has said, we have shown that we can produce (or, at least, that there can be produced) by the cause assumed, all the phenomena which we have in nature, which are supposed to be effects of a like cause.

But, notwithstanding Professor Huxley's great confidence in the evolution theory as it now stands, there are numerous points at which it would appear that strengthening evidence might yet be advantageously applied. It is not within the scope of an address like this, even if I had the ability, to indicate all such weak places. My purpose is merely to point out a phase of the subject, in which microscopists are likely to be specially interested, and upon which the microscope will doubtless cast light, if light is ever obtained.

This introduces us into that mysterious and, as yet, almost unexplored region of the Protista, or Protogenes,—upon the further border of which lies the boundless ocean of organizable, but unorganized, matter, from whose restless waves the new philosophy in imagination witnesses the magic birth of Moner or Amœba, as the philosophers of three centuries ago thought they saw the heterogenetic evolution of the Barnacle Goose. Here is where we are most concerned with the modern evolution theory. Here is the point at which we workers with the microscope are entitled to demand of its advocates an examination of the evidence, and an impartial scrutiny of the arguments founded on it.

One of the most earnest, thorough, and consistent supporters of the theory is Professor Ernst Haeckel; and he says: "the fundamental idea which must necessarily lie at the bottom of all natural theories of development, is that of a gradual development of all (even the most perfect) organisms out of a single, or out of a very few quite simple, and quite imperfect, original

beings, which came into existence, not by supernatural creation, but by *spontaneous generation*, or archigony, out of inorganic matter." He quotes Oken as declaring that "Every organic thing has arisen out of slime," that it "is nothing but slime in different forms," and that "this primitive slime originated in the sea, from inorganic matter, in the course of planetary evolution." He says that "Büchner showed very clearly that * * * the derivation of the different organic species from common primary forms followed as a necessary conclusion, and that the origin of these original primary forms could only be conceived of as the result of a *spontaneous generation*." Further, he translates a passage from the "Philosophie Zoologique" of Lamarck, in which occurs the following expression of opinion: "The simplest animals and the simplest plants, which stand at the lowest point in the scale of organization, have originated, and still originate, by *spontaneous generation*." All of these extracts are approvingly commented on by Professor Haeckel, in his "History of Creation," in which he also sums up the matter thus: "All the naturalists and philosophers with whom we have become acquainted in this brief historical survey, as men adopting the theory of development, merely arrived at the conception that all the different species of animals and plants which at any time had lived, and still live, upon the earth, are the gradually changed and transformed descendants of one, or some few, original and very simple prototypes, which latter arose out of inorganic matter by *spontaneous generation*."

The phrase Spontaneous Generation, as Professor Haeckel employs it, and as we commonly use it, is in fact a generic term covering several specific operations. As it stands in the quotations just read, it is intended to signify any process by which organic forms may be evolved out of unorganized matter without the direct agency of preëxisting forms, whether the process is accomplished in one step or in many. But the thing which arises may be either a living stuff or a living organism. Likewise the thing from which it arises may be either organic or inorganic; that is to say, it may not have been derived from preëxisting organisms or it may have been so derived. We accordingly have four possible combinations of these circumstances, (1) the origination of merely living material from

purely inorganic matter; (2) the origination of living organized forms from the same sort of matter; (3) the origination of living material from dead organic substances; and (4) the origination of living forms from the same kind of substances. Some authors have attempted to designate each of these imaginary processes by a distinct name; but not with entire success. I shall not try to follow any particular system of definition, but shall use the word *abiogenesis* pretty much as Professor Haeckel uses the term *spontaneous generation*;—to designate any supposed process by which living organisms may arise out of not-living substances, without the agency of other organisms. In a measure the word *archebiosis* covers the same ground, since it means simply the origination of life or a living thing.

Now, the ultra doctrine of abiogenesis involves the idea of the spontaneous origination of living forms at the present time, as well as at a distant point in the past. Great Britain has not produced many advocates of this extreme conception. In America I think none of prominence has appeared. Germany has its Haeckel, and France its Pouchet. England has only its Bastian. These are all radicals. To them Evolution is no mere hypothesis. It is already a demonstrated and general fact; and they cannot, or will not, admit any missing links. In their creed unfilled breaks are an impossibility. Living things must have arisen out of not-living, and higher organisms out of lower, in unbroken series. And what has occurred in times past must have been an effect of causes now potent and operative. They permit no heretical leaning towards a belief in extinct causes. They are exceedingly jealous of the uniformity of nature. Its laws are from everlasting to everlasting. What has happened may happen. What takes place now may have taken place at any previous time. The lowest forms of living beings once came into existence *de novo*. They began to be. But not by miracle; they were evolved from things until then forever dead, by physical and chemical processes that may still be evoked, both naturally and artificially. They think they can even point to the bottom of the ascending scale. Haeckel says, in effect, there is the Moner; that is without doubt the simplest possible vitalized unit. But others say there must be something even simpler, for the Moner moves about, takes food, and performs

functions implying a good degree of organization. The ideal beginning is simply a living stuff;—a colloid, plus vitality. In fact, Oken's undifferentiated and unindividualized "*slime*" meets the requirements of the case.

Professor Huxley thought he had discovered this basal material in the renowned Bathybius. Haeckel hailed it as the very ground-floor of the modern biological structure; and the specific name Haeckelii, which was given it, testified to the sympathy between the parent and the God-father. Haeckel confidently accepted Bathybius as the final proof of the evolution theory, and from behind it challenged all doubters to battle; just as Huxley later entrenched himself, once and for all, in Orohippus. But Bathybius proved to be a false hope. It turned out that the wish had been father to the thought;—that Bathybius existed only in the imagination. And so in science it proves to be nearly as difficult to determine what are "essentials" as it is in theology.

Now, the line of separation between a lifeless colloid and a colloid plus vitality seems a very slight barrier, and, *a priori*, it ought to be easily crossed. We have become accustomed to think that in protoplasm we have the bridge. We have been saying for a long time that protoplasm is the ultimate seat of all vital phenomena, in both animal and plant; that as we go down in the scale, organization narrows more and more, until at last the lowest organism consists of no concrete thing but protoplasm. Then we have argued from the other end, saying that the boundary between inorganic and organic substances has been wiped out; that chemists have succeeded in artificially building up organic compounds; and that they may be expected to produce, sooner or later, those most complex of all organic substances, the protein compounds. Then we have looked upon the problem as reduced to a comparatively simple form:—given, artificially created protoplasm, to wake it into life!

Ah yes, but really how much better off are we now than when we approached the matter from the other side? Now it is synthesis, then it was analysis. In either case the essential factor eludes us. When we had the apparently organless Moner or the Amœba before us, we seemed to be at the very entrance of the holy of holies. The curtain was thin and unresisting; it was easy to brush it aside,—but what then? Behold, the spirit en-

shrined an instant before had flown! The profane touch of inquisitive Science had driven it forth, an immaterial, intangible, mysterious power. The very process of investigation made investigation impossible; and, instead of capturing the animating principle, we merely produced a wreck.

It is hard to understand why there may not be as many different kinds of protoplasm as there are different kinds of organisms of which protoplasm is a constituent. Perhaps the apparent similarity in all protoplasmic bodies is only a matter of optics; and that when we have evolved a microscope objective of sufficient power we may discover that the Moner and the Amœba have such complicated organizations that, instead of being at the bottom, they stand midway in the scale of living things.

When we consider the limited range of sight we now have, even with our best appliances, it cannot but seem presumptuous to speak of *lowest* things and *ultimate* structures with anything but a hypothetical signification. At any rate, all that we as yet know of the simplest organic beings that are visible to us, indicates that they have strongly marked characteristics and that they are sharply defined one from another. There is, in fact, no indefiniteness in genealogical lines, nor anything at all resembling heterogenesis, no matter how low down we are able to go.

Because at one point in its life-history Protococcus, for example, can hardly be distinguished from a flagellate animalcule, it would not be safe or scientific to conclude that the one form may pass into, or ever has passed into, the other. For there is no more reason for believing that motile protoplasmic zoospores may, by heterogenesis, develop into Foraminifera, or any other form of Protozoa, than there is for accepting the teaching of Aristotle that grape-vines bloom with living butterflies. Nor is there as yet any more scientific basis for the theory that protococci, or torulæ, or bacteria may arise, or ever have arisen, by abiogenesis, from solutions of salts or decoctions of organic matter, than there is for the notion that Globergerinæ or Foraminifera may develop from vegetable zoospores.

"This," says Professor Haeckel, "is the point at which most naturalists, even at the present day, are inclined to give up the attempt at natural explanation and take refuge in the miracle of an inconceivable creation." But not so Professor Haeckel.

And not so Doctor Bastian. They and their followers are wont to insist that the only doctrine of original generation, which falls in with a proper theoretic acceptance of Evolution, is that of an archebiosis not only applicable to a past time but also valid at the present. This is the theme of Doctor Bastian's vigorous, but not always trustworthy, writings. In his work on "The Beginnings of Life," after treating of solutions containing unstable matter acting the part of a ferment and producing the conditions favorable to "life-giving changes," and expressing his expectation that in a short time "some solution of saline substances may be discovered capable of retaining its power of passing through life-evolving changes, even after having been subjected, within hermetically sealed vessels, to very high temperatures," he goes on to say: "These considerations are replete with interest. They insensibly lead us on to the enquiry, as to whether living things can now originate upon the surface of our globe after the same manner, in which alone (in accordance with scientific teachings and the evolution hypothesis) they could have originated, in those far remote ages, when what we call 'Life' first began to dawn upon the still heated surface of the earth. Before organic materials of the ordinary kind could exist, organisms must have been present to produce them. Organizable compounds of a certain kind must nevertheless have preceded organisms. And just as chemists are now able to build up a great number of so-called organic compounds in their laboratories, so it seems almost certain that some such mobile compounds may have been evolved, by the agency of natural forces alone acting on the heated surface of the earth, at a period anterior to the advent of living things."

But the Bastian and Haeckel school are just now in a hopeless minority. The great majority of professed evolutionists belong to the school of Huxley, Pasteur and Tyndall, whose views were in a general way expressed by the last-named in his celebrated Belfast address, in which he said: "If you ask me whether there exists the least evidence to prove that any form of life can be developed out of matter independently of antecedent life, my reply is that evidence considered perfectly conclusive by many has been adduced, and that were we to follow a common example, and accept testimony because it falls in with our belief, we should eagerly close with the evidence referred to.

But those to whom I refer as having studied this question, believing the evidence offered in favor of spontaneous generation to be vitiated by error, cannot accept it. They know full well that the chemist now prepares from inorganic matter a vast array of substances which were some time ago regarded as the products solely of vitality. They are intimately acquainted with the structural power of matter, as evidenced in the phenomena of crystallization. They can justify scientifically their *belief* in its potency, under the proper conditions, to produce organisms. But, in reply to your question, they will frankly admit their inability to point to any satisfactory experimental proof that life can be developed, save from demonstrable antecedent life."

In his address on "Fermentation and its bearing on the Phenomena of Disease," delivered before the Glasgow Science Lecture Association, in October, 1876, Professor Tyndall again referred to this subject in the following words: "Is there then no experimental proof of spontaneous generation? I answer, without hesitation, *none!* But to doubt the experimental proof of a fact and to deny its possibility are two different things, though some writers confuse matters by making them synonymous. In fact, this doctrine of spontaneous generation, in one form or another, falls in with the theoretic beliefs of some of the foremost workers of this age; but it is exactly these men who have the penetration to see, and the honesty to expose, the weakness of the evidence adduced in its support."

At another time Professor Tyndall, in reply to strictures of Professor Virchow, said: "I share his opinion that the theory of evolution in its complete form involves the assumption that at some period or other of the earth's history there occurred what would be now called spontaneous generation. I agree with him that 'the proofs of it are still wanting.'" Then he quotes Virchow as saying: "Whoever recalls to mind the lamentable failures of all the attempts made very recently to discover a decided support for the *generatio æquivoca* in the lower forms of transition from the inorganic to the organic world, will feel it doubly serious to demand that this theory, so utterly discredited, should be in any way accepted as the basis of all our views of life;" and to this Professor Tyndall adds: "I hold, with Virchow, that the failures *have* been lamentable, that

the doctrine *is* utterly discredited. But my position here is so well known that I need not dwell upon it further."

Like Virchow, Bastian urges upon evolutionists of the Tyndall school the inconsistency of their position on the question of abiogenesis, but, instead of calling upon them to abandon the idea of an unbroken chain of development, on account of the weakness or absence of this link, he attempts to rally them to the defence of the faith in the link not only as existing in the past but as holding as strongly as ever to-day. He says : "the time is doubtless not far distant when it will be a source of much wonder that those who had already heartily adopted the evolution philosophy could, even in the face of facts long ago known, stop short of a belief in the present and continual occurrence of archebiosis and heterogenesis. Do not the very simplest forms of life abound at the present day, and would the evolutionist really have us believe that such forms are direct continuations of an equally structureless matter which has existed for millions and millions of years without having undergone any differentiation ? Would he have us believe that the simplest and most structureless Amœba of the present day can boast of a line of ancestors stretching back to such far remote periods that in comparison with them the primæval men were but as things of yesterday ? The notion is surely preposterously absurd ; or, if true, the fact would be sufficient to overthrow the very first principles of their own evolution philosophy."

Sir William Thomson saw the difficulties involved in this matter and took a bold course to escape them. In his presidential address to the British Association, in 1871, he expressed his willingness to adopt, as an article of scientific faith, true through all space and through all time, "that life proceeds from life and from nothing but life ;" but, as he also saw the logical necessity for a beginning of the living chain upon the earth, he gave it as his judgment that the progenitors of all present organized beings about us were introduced to this globe on "moss-grown fragments from the ruins of another world." This might be called the Theory of Inoculation.

But we have heard Professor Tyndall remark that "to doubt the experimental proof of a fact and to deny its possibility are two different things." And this is, in substance, the burden of Professor Huxley's presidential address to the British Associa-

tion in 1870, in which he said: "I must carefully guard myself against the supposition that I intend to suggest that no such thing as abiogenesis ever has taken place in the past, or ever will take place in the future. With organic chemistry, molecular physics, and physiology yet in their infancy and every day making prodigious strides, I think it would be the height of presumption for any man to say that the conditions under which matter assumes the properties we call 'vital' may not, some day, be artificially brought together. All I feel justified in affirming is that I see no reason for believing that the feat has been performed yet. And looking back through the prodigious vista of the past, I find no record of the commencement of life, and therefore I am devoid of any means of forming a definite conclusion as to the conditions of its appearance. Belief, in the scientific sense of the word, is a serious matter, and needs strong foundations. To say, therefore, in the admitted absence of evidence, that I have any belief as to the mode in which the existing forms of life have originated, would be using words in a wrong sense. But expectation is permissible where belief is not; and, if it were given me to look beyond the abyss of geologically recorded time to the still more remote period when the earth was passing through physical and chemical conditions which it can no more see again than a man can recall his infancy, I should expect to be a witness of the evolution of living protoplasm from not living matter. I should expect to see it appear under forms of great simplicity, endowed, like existing fungi, with the power of determining the formation of new protoplasm from such matters as ammonium carbonates, oxalates, and tartrates, alkaline and earthy phosphates, and water, without the aid of light. That is the expectation to which analogical reasoning leads me; but I beg you once more to recollect that I have no right to call my opinion anything but an act of philosophical faith."

In the case of hybridism Professor Huxley thought experimental proof not only desirable but necessary. In the matter of spontaneous generation, however, he is apparently satisfied with "an act of philosophical faith." When discussing the doctrine of natural selection he declared that Mr. Darwin, in order to place his views beyond the reach of all possible assault, ought to be able to demonstrate the possibility of doing artificially what is done

by nature in the production of new species ; but when considering the theory of abiogenesis,—which undertakes to account for the production of the whole organic world,—he seems content with " the expectation to which analogical reasoning leads " him. As to selective breeding he insisted that, if you have not experimentally accomplished what you assert to have taken place amongst organisms uninfluenced by man, " you have not shown that you can produce by the cause assumed all the phenomena which you have in nature ; " and he had just before declared that "every hypothesis is bound to explain, or at any rate, not be inconsistent with, the whole of the facts which it professes to account for." Now experiments in selective breeding had not demonstrated the impossibility of developing from a particular stock two forms which should either be unable to cross one with another, or whose cross-bred offspring should be infertile with one another. The evidence on that head was inconclusive only, and so Professor Huxley felt warranted in expecting the experiments to succeed at some future time. But in regard to the accomplishment of abiogenisis, it is pretty clear that he turns no very confident eye to the future. The "expectation" of which he speaks in this case is, strange to say, wholly of the past. To be sure, he looks with interest, and perhaps some slight hope, upon the progress of synthetical chemistry ; but the philosophical faith which he professes with most confidence has reference to what he imagines took place " when the earth was passing through physical and chemical conditions which it can no more see again than a man can recall his infancy."

It may be that Huxley, Tyndall and other specialists do not consider it incumbent on them to look out for the entire line of battle. They perhaps think their duty fully performed when they engage the enemy in their immediate front. Darwin certainly did not regard himself as responsible for the whole theory of evolution. He distinctly declared that his concern was with the higher forms of organized beings and that he had nothing to do with the beginning of life or of living things. In one of his letters to Sir Joseph Hooker, written in 1868, he said : "It will be some time before we see 'slime, protoplasm, &c.,' generating a new animal. * * * It is mere rubbish, thinking at present of the origin of life ; one might as well think of the origin of matter." ubsequently, when Dr. Bastian put

forth his too positive statements as to the results of his experiments, Mr. Darwin seems to have been somewhat puzzled, though still incredulous. Writing to Professor Wallace in 1872, he said: "As for Rotifers and Tardigrades being spontaneously generated, my mind can no more digest such statements, whether true or false, than my stomach can digest a lump of lead. Dr. Bastian is always comparing archebiosis, as well as growth, to crystallization; but, on this view, a Rotifer or Tardigrade is adapted to its humble conditions of life by a happy accident, and this I cannot believe." Then he went on to show that, like others, he saw the necessity of the spontaneous generation theory to the general theory of evolution, but also to manifest the inherent honesty of his mind which forbade his accepting the theory on purely *a priori* grounds; for he says: "I should like to live to see archebiosis proved true, for it would be a discovery of transcendant importance; or, if false, I should like to see it disproved, and the facts otherwise explained; but I shall not live to see all this." A year later he wrote in this same strain to Professor Haeckel, to whom he was sending a "singular statement bearing on so-called spontaneous generation," saying: "I much wish that this latter question could be settled, but I see no prospect of it. If it could be proved true this would be most important to us." These seem to be the only instances in which he referred to the subject. As I have already said, he did not, as a general thing, concern himself with problems connected with the origin of the living series. His special work with its latest and highest products was enough to fully occupy his mind and satisfy his spirit of inquiry. Nearly all the broadening and elaborating of the evolution philosophy, which his own labors made possible, was foreign to his intellectual habit and temperament, and he had frequent occasion to "groan" over what he considered the impetuosity and rashness of some of his more speculative friends.

But Herbert Spencer is, in a sense, the commander-in-chief of a philosophical army, in which Huxley, Tyndall, Haeckel, and Wallace are division commanders. He recognizes his responsibility for the coherency and effectiveness of the whole system, and is obliged to have his eye first here and then there, with a view to strengthening and consolidating at every point. As soon

as he saw the line of spontaneous generationists breaking, he comprehended the gravity of the situation. I suppose he realized that we should have to relinquish the idea of uniformity in nature if archebiosis occurred but once, in the dim distant past. Perhaps he also appreciated the danger his theory of variation was in, if the lowest living things of to-day must be regarded as the unchanged descendants of an almost infinite line of perfectly invariable ancestors. At any rate, the problem which he undertook to face was the modification of his philosophical system so as to admit of continual evolution of vitalized matter, without giving countenance to the experimentally discredited notion of a direct origination of living organisms. To this task he applied himself in his essay on "Spontaneous Generation and the Hypothesis of Physiological Units; A Reply to the North American Review," written in 1868, and afterwards appended to his "Principles of Biology."

In that essay he says: "That creatures having *quite specific structures* are evolved in the course of a few hours, without antecedents calculated to determine their specific forms, is to me incredible. Not only the established truths of biology, but the established truths of science in general, negative the supposition that organisms, having structures definite enough to identify them as belonging to known genera and species, can be produced in the absence of germs derived from antecedent organisms of the same genera and species. If there can suddenly be imposed on simple protoplasm the organization which constitutes it a *Paramecium*, I see no reason why animals of greater complexity, or indeed of any complexity, may not be constituted after the same manner. In brief, I do not accept these alleged facts as exemplifying Evolution, because they imply something immensely beyond that which Evolution, as I understand it, can achieve. * * * The very conception of spontaneity is wholly incongruous with the conception of Evolution."

It is apparent that the stumbling-block with Mr. Spencer is the idea that well-defined *organisms* can arise directly out of not-living matter, for I understand him to entertain no prepossession against a belief in the continual, but gradual, origination of living substances from even inorganic compounds. It seems, however, as if he fancied it easier to conceive of the evolution

of vital units if they were only extremely small and practically characterless; and, like other evolutionists, he appears to attach great importance to the influence of mere temperature in the production of the very first living things; for he says: "Granting that the formation of organic matter, and the evolution of life in its lowest forms. may go on under existing cosmical conditions; but believing it more likely that the formation of such matter and such forms took place at a time when the heat of the Earth's surface was falling through those ranges of temperature at which the higher organic compounds are unstable; I conceive that the moulding of such organic matter into the simplest types must have commenced with portions of protoplasm more minute, more indefinite, and more inconstant in their characters, than the lowest Rhizopods,—less distinguishable from a mere fragment of albumen than even the *Protogenes* of Professor Haeckel."

Such minute, indefinite, and inconstant fragments of albumen are of course very different things from the forms which Pouchet and Bastian found in their hermetically sealed culture tubes; and Mr. Spencer declares that he "can penetrate deep enough to see that a tenable hypothesis respecting the origin of organic life must be reached by some other clew than that furnished by experiments on decoction of hay and extract of beef." As we now know, the experiments to which he refers really furnished no clew whatever. But the complete demolishment of Pouchet and Bastian by Pasteur and Tyndall is a matter of comparative insignificance, in view of the avoidance of the whole subject of experimental evidence by Mr. Spencer's adoption of the position that the conception of "first organisms" is wholly at variance with the conception of Evolution; that there is not and never was any such thing as an absolute commencement of life. On this subject he says: "Construed in terms of evolution, every kind of being is conceived as a product of modifications wrought by insensible gradations on a preëxisting kind of being; and this holds as fully of the supposed 'commencement of organic life' as of all subsequent developments of organic life. It is no more needful to suppose an 'absolute commencement of organic life' or a 'first organism' than it is needful to suppose an absolute commencement of social life and a first social organism. * * *

That organic matter was not produced all at once, but was reached through steps, we are well warranted in believing by the experience of chemists."

Further on he dismisses the subject thus: "Setting out with inductions from the experiences of organic chemists at the one extreme, and with inductions from the observations of biologists at the other extreme, we are enabled deductively to bridge the interval,—are enabled to conceive how organic compounds were evolved, and how, by a continuance of the process, the nascent life displayed in these became gradually more pronounced. And this it is which has to be explained and which the alleged cases of 'spontaneous generation' would not, were they substantiated, help us in the least to explain."

The position, then, of the better part of the scientific authorites is that the Spontaneous Generation Theory is a necessary part of the General Theory of Evolution, but that no experimental evidence has as yet been produced in support of the belief in the occurrence of abiogensis, and that therefore the Evolution Theory hangs upon a link of pure faith.

All the scientists whom I have quoted, except Herbert Spencer, evidently believe that life once had an actual beginning upon the globe,—that there was a first living form. Not that there came into existence an original individual, but that numberless vital units of a single kind began to be. They also plainly agree that the same class of organisms exists in countless numbers at the present time; and I confess that it seems to me that, unless they are ready to admit that these organisms are now from day to day evolved from lifeless substances, they are bound to assent to Doctor Bastian's proposition that such changeless forms are direct continuations of long lines of equally simple ancestors reaching back to those far remote ages when, as Professor Tyndall says, "what we call Life first began to dawn upon the still heated surface of the earth." And yet, while holding to this extraordinary permanency of form in order to escape the dilemma of present archebiosis, they of course conceive of these changeless beings as in some way embodying the initial impulse to diversity, upon which natural selection has had to work. Instead of an unstable, plastic, variable basis of life, we are hence provided with a rigid, resisting primordial matter out of whose utter

indifference to changing conditions arises that sensitiveness to the environment which is the very essence of the evolution hypothesis.

To my mind, the only escape for out-and-out evolutionists from this contradictory position is in admitting that life and living things are originating by some process to-day ;—that the principal notes in the evolutionary chord are all still sounding, from the lowest to the highest. If one cannot accept the doctrine of spontaneous generation as formerly advocated by Buffon and Needham, and more recently by Doctor Bastian, and still desires to stand by the general theory of evolution, it seems to me he must adopt the idea implied in Herbert Spencer's essay from which I have just quoted ;—that inorganic matter is now evolving into organic substances, just as it has always done ; that organic substances are acquiring vital functions and rising to the grade of organized forms at the present time, exactly as they have been doing through all time. I am not sure that Mr. Spencer distinctly avows this belief, but it appears to be a natural inference from his teaching on the subject.

But, whether he is actually convinced that the evolution of life is and always has been continuous, or holds to the view, more generally accepted by evolutionists, that the vital series began but once, his definition of evolution, as we have seen, provides for the accomplishment of its results by *insensible* gradations ; by which I suppose he means changes immeasureably, or perhaps infinitely, small and gradual :—transitions which we not only cannot accurately calculate but probably cannot even imagine. This introduces into the process an occult quality which to most minds will not seem strictly scientific, and I fail to find that any of the other advocates of the evolution hypothesis have fully grasped and adopted this conception. Although Mr. Spencer propounded his theory of the matter some twenty years ago, there has been a singular silence with reference to it by other scientific philosophers. In fact, most of them have dropped the discussion of the subject, as if all theories of spontaneous generation had been exploded, except such as are built upon faith in what may have happened naturally in the primæval past, or upon hope of what may be accomplished artificially in the far distant future. Amongst all the scientists and philosophers with whose writings I am famil-

iar, Mr. Spencer appears to be the only one, however, who has plainly avoided the application to the problem of experimental tests, and has escaped the inferences therefrom, by pleading that at this juncture a factor of infinity is introduced :—that the transitions one would seek to trace are so "*insensible*" that endings and beginnings have no existence. Meanwhile the investigations of bacteriologists are piling higher and higher the proof of the old doctrine, "*omne vivum ex vivo*," and making it more and more certain that there is no confusion of genetic lines amongst even the "lowest" living forms.

And here I must leave the subject, lame and impotent though the conclusion may be. I have not undertaken the discussion of this topic in any spirit of captiousness, nor with any prejudice against the evolution theory. In the domain in which Mr. Darwin worked I look upon Natural Selection as a well-established principle. In the developmental idea as extended and expounded by Herbert Spencer I find much that appeals strongly to my sense of fitness and consistency and, if possible, I could see the hypothesis become a proven law of nature without a shock to my mental or moral status. I have no fear of anything that is true.

But what I have endeavored to show is :

1. That a transition from not-living matter to living forms is an essential step in the process of evolution.

2. That at the point at which experimental proof is applicable (namely, to present and continual archebiosis) the theory of such a transition is discredited, if not disproved.

3. That scientists generally accept this conclusion, and that those who are thorough evolutionists are confined to the mere belief that the step from the not-living to the living was taken at some remotely early period, beyond the reach of evidence.

And, finally, I submit, as a consequence of these premises, that the General Theory of Evolution is still in the stage of *hypothesis*, and that in the gap between lifeless substances and living forms we have the veritable "*Missing Link.*"

PRELIMINARY LIST OF THE FORAMINIFERA FROM THE POST-PLIOCENE SAND AT SANTA BARBARA, CALIFORNIA.

BY ANTHONY WOODWARD.

(*Presented December 21st*, 1888.)

This formation is well exposed in the cliffs along the shore west of Santa Barbara, and in some places attains a thickness of a hundred feet. It consists of strata of coarse gravel and sand, some of which are consolidated into the hard sandstone, while others are still quite soft and easily disintegrated.

The formation thus exposed on the beach at Santa Barbara is extremely rich in fossils, nearly all of which are of living, while a small number are of extinct species.*

The material which I examined, was a small sample, presented to me by my friend, Mr. James Terry. Judging from the richness of the following results, I am confident that if I had access to a larger quantity, many of the species marked rare would be found very abundant, as in the case of *Polystomella crispa*, which was present in great numbers. Hoping soon to receive a large supply of the sand, I expect to be able to give a more detailed list.

Biloculina ringens, Lamarck, sp. Rare.

Spiroloculina limbata, d'Orbigny. Quite rare.

Miliolina auberiana, d'Orbigny, sp. Not abundant.

Miliolina seminulum, Linné, sp. Common.

Miliolina subrotunda, Montagu, sp. Rare.

Miliolina tricarinata, d'Orbigny, sp. Abundant.

Miliolina trigonula, Lamarck, sp. Abundant.

Miliolina venusta, Kerrer, sp. Not abundant.

Cornuspira foliacea, Philippi, sp. Quite rare.

Cassidulina crassa, d'Orbigny. Quite rare.

Lagena globosa, Montagu, sp. Rare.

Cristellaria costata, Fichtel & Moll, sp. Quite rare.

*Geology of California, vol. i., p. 134.

Cristellaria cultrata, Montfort, sp. Rare.
Cristellaria rotulata, Lamarck, sp. Quite abundant.
Cristellaria variabilis, Reuss. Rare.
Polystomella crispa, Linné, sp. Common.
Polymorphina elegantissima (?). Rare.
Uvigerina pygmæa, d'Orbigny. Rare.
Truncatulina lobatula, Walker & Jacob, sp. Common.
Pulvinulina elegans, d'Orbigny, sp. Not common.
Pulvinulina hauerii, d'Orbigny, sp. Not rare.
Pulvinulina karsteni, Reuss, sp. Quite rare.
Pulvinulina lateralis, Terquem, sp. Rare.
Pulvinulina punctulata, d'Orbigny, sp. Rare.
Spœroidina bulloides, d'Orbigny. Rare.
Rotalia beccarii, Linné, sp. Not rare.
Discorbina orbicularis, Terquem, sp. Abundant.
Anomalina grosserugosa, Gumbel, sp. Common.

HAY-FEVER: ITS TREATMENT PHYSIOLOGICALLY AND PATHOLOGICALLY CONSIDERED.

BY DR. N. C. HUSTED.

(*Read December 7th*, 1888.)

That Hay-Fever belongs to the Neuroses, has become an established fact; and, when the most eminent of our recent writers on this subject have brought forward such overwhelming proofs to show, that it is an affection of the nervous system, it seems folly to entertain any theories or ideas appertaining to its pathology, etiology or treatment, which are not based on a neurotic hypothesis. To the layman's mind it may seem strange that eminent writers should not come to any agreement concerning this troublesome affection; but, notwithstanding the fact that the nerve-theory has placed Hay-Fever on a new foundation, from which we may feel assured many bright superstructures will arise, yet many questions come before us, which will give rise to much future discussion.

In recognizing Hay-Fever as a nervous affection, certain questions naturally arise from such an hypothesis:

I. Is Hay-Fever of Neurotic *origin?*

II. If so, does it begin primarily, (*a*) in the central nervous cells, (*b*) in the nerve-trunks, or (*c*) in the terminal organs?

III. Are pathological lesions present?

IV. Is there an inflammation of the mucous membranes, giving rise to nervous hyperesthesia?

In the New York *Medical Record* of July 14th, 1888, Dr. B. O. Kinnear, of Boston, gives an interesting paper, in which he states, and endeavors to prove, that Hay-Fever is a disease of *central cell origin.* His argument shows deep study and a logical train of thought, and, although believing his premises to be faulty, I think the article adds greatly to our literature of the subject.

Explanation of Plate 15.

Human nerves and mucous membrane as related to Hay-Fever.—*mm, mm,* mucous membrane; *sc,* spinal cord; *cg,* Casserian ganglion; *oph,* ophthalmic nerve; *f,* frontal branch; *n,* nasal branch; *l,* lachrymal branch; *sm,* superior maxillary nerve; *gp,* glosso-pharyngeal nerve; *p,* pneumogastric nerve; *sp,* superior pharyngeal branch; *sl,* superior laryngeal branch; *b,* bronchial branch.

HUSTED ON HAY-FEVER.

In support of his hypothesis, Dr. Kinnear makes use substantially of the following facts : Grief causes the tears to flow, the muscles of the face to contort, and induces rapid failure of muscular strength. Mental excitement acts on the secretions of the kidneys. Nausea and vomiting are often caused by a disgusting sight or smell. Joy and anger flush the face. Sneezing is an effort of Nature to throw off the foreign body from the mucous membrane of the nose, &c.

These are reflex acts giving rise to hyperactivity and hypersecretion. He reasons from this, that abnormal nerve-force, due to disease of the *central cells*, will give rise to abnormal effects on the system ; *i. e.*, disease of the central ganglion, connected with the nerves supplying the mucous membrane of the nose and throat, causing what he calls abnormal nervous force, produces abnormal secretions from these parts. At the same time he declares Hay-Fever paroxysms to be reflex acts. Which is very true ; thus showing the fallacy of his theory, that the disease originates in the central nerve-cells. Now a reflex act is due to the stimulation and irritation of a sensory nerve, over which the impulse travels ; the central cells acting only to receive this impulse, and transmit it to the motor nerves. By this it will be seen, that a reflex act cannot take place, unless the impulse be first carried along a sensory nerve to the cell. And therefore Dr. Kinnear's assumption, that a diseased condition of the cells originates the reflex act, and its subsequent phenomena, seems to me to be false. In fact, he must deny the existence of all the well-known etiological factors, when he assumes that the disease is of central nervous origin.

After a careful study of this affection, and believing it to be a disease of the nervous system, I have arrived at the following conclusions, which seem at least to be based on physiological, pathological and common-sense principles. Hay-Fever is a periodic, Neurotic disease, occurring in persons having a peculiar idiosyncrasy, or constitutional diathesis, and characterized by a hypersecretion of the nasal and pharyngeal mucous membranes. The paroxysms are reflex acts, due to an irritation of the *terminal fibres* of the nerves, supplying the nasal and pharyngeal mucous membranes. The impulse is carried along the sensory nerves to the central cells in the medulla, which, on receiving the impulse, transmits it to the vaso-motor system,

producing a congestion of the parts, from which the impulse originates. This abnormal blood supply increases the nutrition of the mucous membrane, giving rise to a hypersecretion of the mucous glands.

The blood-supply of the body is regulated by the great sympathetic nervous system, which surrounds the arteries, and the sympathetic nerve-endings are supposed to terminate in the muscular coats of the arteries. Any thing, which affects this system of nerves, will cause either contraction or dilatation of the vessels, thus diminishing or increasing the blood-supply of the part. A common illustration of this fact is shown when, on approaching a hot fire, the skin becomes red, and the action of the heat on the nerves of the skin causes the capillary blood-vessels to dilate, and thus increasing the action of the sweat glands, the surface becomes moist. In the same manner the application of cold to the surface causes contraction of the capillaries. Stimulation of certain nerves, connected with any organ or tissue of the body, will cause a determination of blood to those parts, and a hyperactivity.

The amount and continuance of a congestion, or hyperæmia, depends on the duration, rather than on the amount of irritation present. A severe cut on the surface of the body, with some sharp instrument, causes local hyperæmia of the surface incised, while it is comparatively of short duration ; while the prolonged presence of a splinter, or other foreign body, will cause severe inflammation, which may ultimately end in gangrene. Such illustrations show the influence of the nerves over the arterial system, and demonstrate to us that the nerve-theory of Hay-Fever is not altogether unfounded.

It may easily be seen from the above facts, how certain substances, coming in contact with the mucous surfaces of the nose and throat, will set up an irritation in the terminal nerve-fibres ; and how this irritation, in the form of nerve-impulses, keeps flashing along the sensory nerves to the switch-men in the medulla, who, in the form of nerve-centres, having no action of their own, irrespective of events taking place elsewhere in the body, receive their elective despatches, and faithfully transmit them down the cervical spine, and, by means of the cervical sympathetic system, dilate the nasal and pharyngeal capillaries, thus causing the familiar discharges from the nose and throat.

Physiologists have time and again proven for us these reflex acts ; we are constantly seeing them illustrated in our every-day life ; and surely their connection with this disease is not beyond the range of possibility.

There is another factor, which enables us to regard Hay-Fever in the light of a Neurosis. This is its almost exclusive confinement to patients in the higher walks of life. As the human race advances to higher degrees of civilization and refinement, in direct proportion do the Neuroses multiply among our aristocracy, and each successive generation shows us the increase. The Anglo-Saxon race appears to be alone liable, English and Americans being those who are almost exclusively affected. As to Temperament,—it almost always occurs in the nervous and energetic.

Sir Morell Mackenzie, in his work on Hay-Fever, quotes a case, in which a young lady, who was a victim of Hay-Fever, on visiting the Royal Academy, was so struck with the realistic representation of Hay-Fever, that she was at once seized with a severe paroxysm of her complaint, from which she was at the time free. Dr. Mackenzie thinks she must have passed a hay-cart on her way to the academy. It seems probable that in a person of highly sensitive nervous organization, such a sight would act reflexly on the nerves, already in a state of hyperæsthesia, and produce the paroxysm. The sight or thought of anything sour will cause an increase in the salivary secretion ; and so this case seems to bind us still closer to the nerve-theory of Hay-Fever. Why is it that some of us suffer, while others enjoy immunity ? For the same reason that, on exposure to some contagious disease, one man will contract it, and the others escape. We give it that very convenient but unfortunate term, " idiosyncrasy,"—that peculiar liability, some of us have, to contract certain diseases, which we can not as yet explain, and which is often hereditary.

The active cause of the irritation causing Hay-Fever still remains unsettled, to a certain extent ; but the majority cling to the pollen theory. I would raise the following questions :

I. The pollen from vegetable life acts as a direct irritant to the nerve-endings in the mucous membrane.

II. The pollen, or atmosphere, contains bacilli, which act as a ferment, on entering the blood.

III. The nasal membrane is kept moist by the secretion from the mucous glands.

The mucous membrane is covered with ciliated epithelium, the cilia being continually in a state of motion. Now if, from any cause, these cilia are in a state of hyperactivity, it can be seen how the mucous, instead of accumulating and keeping the membranes moist, will be thrown off, as it accumulates, and the membrane, becoming dry, is easily irritated by the presence of foreign bodies. This, seems to me to be a possible explanation of the fact, that Hay-Fever attacks only the favored few ; the hyperactivity of the cilia depending on the Neurotic diathesis of the patient. It is well known that the atmosphere is filled with bacilli of different species, which are innoxious until they find a mucous membrane favorable to their growth. The Hay-Fever bacillus has not yet been captured ; and it is possibly lurking in the air we breathe, waiting to pounce down on the mucous membrane of those of us, who present a favorable predisposition. The ideas presented are merely suggestive, there being no space for their discussion in this paper.

On starting this paper, I had determined to make no mention of symptomatology. The symptoms are well known to most of you here present. But certain circumstances have determined me to speak of a very distressing one. The difficulty of breathing, and tightness about the chest, and cough, are regarded by many as the extension of the pharyngeal inflammation to the air-cells of the lungs. When the cellular tissue of the lungs becomes inflamed, something more serious than an asthmatic attack is going to happen. In fact I do not consider Hay-Fever to be accompanied by inflammation ; for inflammation always leads to proliferation, and destruction of tissue. I regard it merely as a congestion, which does not get as far as inflammation. These chest symptoms are plainly due to irritation of branches of the pneumogastric nerve. As we know, branches of this nerve are distributed to the lungs ; it has also branches which form a part of the pharyngeal plexus. There can be no question that stimulation of this plexus will excite the branches which supply the lungs.

The Treatment.—Numerous remedies are proposed every year, but none of them do more than give partial or temporary relief. A gentleman, visiting a suburban town, had occasion to

call a physician in the night to prescribe for a severe paroxysm of this disease. The good old country doctor came, felt of his pulse, and enquired if he had tried any remedies. "Yes," he replied, "I have been trying *remedies* all my life, and now I want something to *cure* me."

Any treatment of Hay-Fever, to be effectual, must be based on a correct theory of its causation. Recall the fact, that the nasal and pharyngeal capillaries are in a state of engorgement, caused by the action of the nerve-impulses, which start in the plexuses of those parts, on the central cells of the sympathetic system, whose duty is to keep these vessels in a state of contractility. It seems evident from this, that anything, which will cause the sympathetic nerves to regain their normal condition, will relieve this congestion in the capillaries. This is done by the use of Chapman's ice-bags. They must be applied to the spine, and remain there from ten to fifteen minutes, and even as long as an hour, at each attack. After three or four applications, it will be found that the attacks will be warded off, or I may say the disease will be arrested. During the past year, some half dozen cases came under my care. I found the ice-bag to invariably arrest the attacks, and, in one particular case, the attacks have not recurred. Thus far I consider it a cure.

NOTES ON A NEW OCHRACEOUS THALLOPHYTE.

BY ALEXIS A. JULIEN, PH. D.

(*Read January* 18*th*, 1889.)

In the month of July, 1886, I observed and collected a curious ferruginous plant-growth, which occurred on the sides and in the basin of a cold spring, at a point on the Shark River, in Monmouth County, New Jersey, and which resembled the so-called *Leptothrix ochracea*, Kützing, of Europe, in general appearance. Early in September of the same year, another occurrence was discovered by a friend, which I have since visited and examined, at several points along a large brook, called the Sandburg, near Mountaindale, Sullivan County, New York. Soon after, the same growth made its appearance in tanks of our laboratory, into which water plants from the

Shark River had been transferred, and has since been cultivated with little difficulty. In November, 1887, I discovered a third locality in Monmouth County, about five miles east of that on the Shark River, near the seashore, at Ocean Beach, New Jersey.

At all these three points and in the tanks, more complex associated forms have been since obtained and were at first attributed to the *Cladothrix dichotoma*, Cohn, and *Crenothrix Kühniana*, Zopf, of Europe.

The study of abundant material, from the natural localities and laboratory-cultures, has shown that we have, at last at these localities, and perhaps at other reported American occurrences of supposed *Crenothrix*, a new genus of aquatic fungus of algoid habit, which is a true schizomycete, branched, and apparently the largest bacterium yet found, with filaments often 15 millimeters or more in length.

In advance of the full description of this interesting plant, a brief statement of its more important morphological characteristics will be here presented.

Though remarkably pleomorphic, all the stages of its growth are sharply distinguished within two classes, the vegetative or unicellular, and the reproductive or multicellular.

From a microspore of ordinary form, leptothrix of various kinds is produced by sprouting, viz., gently curved and twisted filaments, irregularly bent spirochate and screw-filaments, spirilla and vibrio-forms, all with distinct and thick sheaths, often still more thickened by gelatinization and excretion of ferric hydrate. Within the leptothrix-filaments, a condensation of protoplasm ensues, producing, in some cases, cylinders and granules, equal-sized cocci, and even arthrospores ; in others, chains of connected bacilli, which may multiply by fission and sometimes themselves develop minute endogenous spores. These chains emerge from the original sheath and soon reveal their investment by a still more delicate sheath, from which, in turn, new chains of rectilinear elements emerge and generally break up into their constituents. Both in the original leptothrix and its secondary chains, many of the rods are often bent or curved, sometimes vibrio-like, and by pressure, sometimes penetrate the thinner sheath of the chains, and, so diverging from the axis of the filament, form branches at a small angle.

Under certain conditions, this branched form of bacillated leptothrix may develop largely, and it tends strongly to gelatinize, with a condensation of the jelly-coat into one or even two successive outer sheaths. In these, a breaking up into long streptococci-chains commonly occurs, which, by separation at the anterior end, project from the filament in gracefully drooping branches and finally become broken off. The branched leptothrix, in other cases, produces small elliptical sporangia, containing fine micrococci, which, after separation from the filament, burst by gelatinization and form minute zooglœa-masses, full of sprouting cocci. These may rise to the surface of the water and create sometimes a blue metallic pellicle, sometimes a dry mycoderm, made up of clusters of immobile bacilli, sprouting cocci, leptothrix passing into chains of bacilli by fission, etc. But, in other cases, they become saprophytic, attach themselves to dying water-plants, and develop masses of colorless zooglœa, sometimes several decimeters in length and with corresponding thickness, full of clusters of bacilli or of mycelial filaments.

With these, the special reproductive condition of the plant begins, these filaments being invariably sheathed, articulated, irregular in course, branched largely at right angles, and soon putting forth delicate apple-shaped sporangia. From the arthrospores of the original leptothrix, also, similar articulated filaments are generated through an interesting series of products of segmentation and sprouting. These also gelatinize, first, by a coating of irregular granules of jelly or lines of micrococci, some of which occasionally diverge in streptococci-chains, and, finally, by a dense coat which may itself become invested by an exterior sheath. The protoplasm within the cells becomes condensed in cylinders, irregular balls and granules, equal-sized cocci (subdividing in fours), and often arthrospores, as in the leptothrix. Where the terminations of two short branches, projecting at right angles from neighboring filaments, happen to come in contact, union of the branches takes place, and an arthrospore may be formed at the point of contact. Exterior or exospores are also abundantly formed along the filaments, sessile, on short pedicels, or at the termination of filaments.

In actively growing filaments, especially in water poor in iron, chlamydospores are also sometimes formed in abundance, single, or in series of two, three or more, and also on the end of short

hyphæ. Some of the latter assume the character of sporangia, becoming filled with short bacilli. While no sexual process of reproduction has been yet made out, other bodies, besides those above described, are under examination, which seem to yield spores within large capsules. From certain of the spores already referred to, the original leptothrix is again developed.

THE LARVA OF ATTAGENUS PELLIO, AND ITS WONDERFUL ARMOR.

BY DR. H. HENSOLDT.

(*Read October 5th*, 1888.)

Attagenus pellio is a very small beetle, allied to the *Dermestidæ*, of which at least a dozen species have been described. The body of the beetle is oval, and almost entirely covered with short hairs. The thorax is dark brown. The wings are of a lighter brown, with six or more spots of the color of iron rust, while the abdominal end again is dark brown. These beetles are by no means rare, and most of the species appear to live on flowers, nibbling the petals and stamens. They are found from early Spring to the middle of June, when, after having deposited their eggs, most of them die. All the species are characterized by the peculiarity, that when disturbed they contract their antennæ and legs, and feign death.

The larva is about one-eighth of an inch in length, and slightly flattened and tapered towards the abdominal extremity. The legs are short, and the head is very small. The larva lives on decaying wood, but, like others of its type, it may be found also amongst the dried skins of animals, in butterfly collections, where it is a pest, and under carpets, old boxes, &c. It casts its skin several times before changing into a pupa, and the empty skins are of common occurrence in the places frequented by the tiny creatures.

The body of the larva is covered with hairs of three orders.

In the first instance the abdomen ends in a long tail, or pencil of hairs. These long hairs are furnished with an immense number of minute spines, closely appressed to the shaft. But they present nothing very uncommon among insect hairs.

The hairs of the second order are short, somewhat club-shaped, and occur in rows of single file, one row on either extremity of each segment. Their structure is almost identical with that of the hairs of the first order, only their spines seem to stand out a little more laterally. The hairs of the third order I have called "arrow-hairs," because they resemble nothing so much as miniature arrows. This name however can only convey a general idea of their outward appearance. In the wonderful elaborateness of their design and the details of their structure they are very different from any arrow ever made.

The "arrow-hairs" are usually situated in single rows between the pairs of rows of club-shaped hairs. But each of the last three segments, instead of a single row, carries a dense tuft of "arrow-hairs," closely packed with their points standing out like a forest of spears. Their shaft is cylindrical, and carries from twenty to forty spiny whorls, resembling little funnels placed one inside of and slightly above the other, or more, perhaps, a child's necklace of lilac blossoms. These whorls are angular, with four spiny processes hollowed out like a cup. They are succeeded by a sort of shield, a structure agreeing in general outline with the spiny whorls, but of at least double the dimensions of the latter. Above this shield, and connected with it by a sort of neck, arises the arrow-head. This is conical in shape, and is about five times as long and two or three times as broad as one of the spiny divisions. The "system of four," noticeable in the whorls and shield, is here also maintained, but instead of bristling spines we have here long ribs, which form an elaborate system of barbs at the base rising to a point at the apex.

Under a "quarter-inch" objective the extremity of the arrow does not appear very sharp, indeed it is almost a little rounded, But in reality it is wonderfully fine and many times sharper than the sharpest needle. Fifty of these hair-extremities could be crowded into the space occupied by the point of a fine needle.

I draw attention to this because it has a bearing on the theory which I have formed respecting the function of these hairs. In my opinion these hairs, pretty and graceful though they appear, are not intended for ornamentation, nor are they the remnants or rudiments of appendages whose usefulness lies buried in the past. There can be little room for doubt that they are of great

advantage to the larva now, and that they serve as a powerful means of defense. Of course the little creature does not shoot off its arrows, like a bowman of mediæval times, or, as according to popular belief, the porcupine shoots off its quills, but, like the spines of hedgehog and porcupine, these peculiar hairs protect the otherwise defenseless creature by presenting a formidable array of sharp points to the voracious foe. This larva of *Attagenus*, living as it does under the bark of decaying trees, in old skins, carpets, boxes, butterfly-collections, etc., is not so much exposed to the danger of being eaten up by birds as by other and bigger larvæ, centipedes, ants, &c., and against these the hairs, in my opinion, are an efficient protection. The arrow-heads, being much finer pointed than the finest needle will pierce any skin or substance, not absolutely hard, the very instant they are touched. Being barbed in a very elaborate manner and only attached to the shield by a thin and brittle neck, they break off and remain in the skin, causing no doubt acute pain. I have observed many of these larvæ and have found that they can be handled with impunity, owing to the thickness of the skin of our fingers, but the moment I rubbed them against my lips I felt a burning sensation, almost like that caused by a nettle-leaf, which would last for several minutes. From the apex of the arrow-head, down through the entire length of the hair a tube or canal extends (distinctly visible even with a half-inch objective) and this, there can be no doubt whatever, is filled with a poisonous or acid substance, which causes what to us is a slight inflammation, but what may be agony and death to little insect enemies.

That the heads can be easily detached from the hair is a fact which may be verified by experiment at any moment, and that they are intended to break off and torment attacking enemies is extremely probable. I am also perfectly convinced that the hairs, when deprived of their "heads," are not only capable of reproducing the latter, but that they invariably do so, as long as they remain attached to the skin of the living insect. When the head is gone the "shield" is modified into a new head and the next link or division of the stem into a shield, and this process may be repeated a dozen times if necessary. The funnel-shaped spiny whorls are merely incipient heads, each intended to take the place of the one preceding it, if the contingency arises.

Now it may strike us as curious that the last three segments of the body of this larva should be provided with such an immense number of "arrow-hairs," while each of the others carries only a single row. The habit of the creature will, however, explain it. When disturbed it generally rolls itself into a kind of ball, or contracts its body in such a manner as to expose chiefly these formidably armed abdominal segments. The "arrow-hairs" then spread out in all directions, a bristling forest of bayonets, in which a warm reception awaits the incautious intruder. Insects, such as ants, etc., though protected by a hard, chitinous envelope, have their vulnerable points. Their armor-plates are generally joined by a membrane quite thin and soft and easily pierced or irritated.

I have gone to this length of description because I wished to draw your attention to a remarkably beautiful object for the microscope, which is easily obtained, though the preparation of the slide is attended with some difficulties, owing to the tendency of the hairs to become entangled when placed on the glass slip. Attempts to separate them by means of fine needles are mostly futile or result in a general demolishment. The easiest way of preparing them is by securing the cast skins, which are to be found in almost every insect collection. From these skins the hairs can be easily detached and pieces of the skin can also be mounted with the two kinds of hairs *in situ*, or the entire skin, after having been soaked awhile in turpentine, can be spread out and mounted in Canada-balsam—a most beautiful and interesting object. I have here, to-night, about a dozen of these hair-slides, all prepared from cast skins, some showing only the loose "arrow-hairs," others small pieces of the skin with both kinds of hairs, and a few exhibiting the entire skin.

You will find these larvæ if you look for them, and if you should not succeed, catch and kill half a dozen butterflies, put them in a card-board box (in Spring or Summer, of course) and I guarantee that in less than four weeks you will have as many of the larvæ, feeding on the bodies as you can manage to put under cover-glasses.

Of course I am not the original discoverer of these "arrow-hairs." They were known, I dare say, long before my time, but I have never seen a satisfactory description of them anywhere and, considering their beauty and interest it is surprising to

notice how little they are known, even among old microscopists. Carpenter, on p. 702 of the 5th edition of his work on the microscope, very briefly refers to them, and gives a very inaccurate sketch of one which he simply calls *Dermestes*, although this genus embraces about a dozen species, none of which, as far as I am aware, is characterized by these wonderful "arrow-hairs."

PROCEEDINGS.

Meeting of October 5th, 1888.

The President, Mr. Charles F. Cox, in the chair.

Twenty-eight persons present.

The President congratulated the Society on re-assembling after the Summer recess; and read a Paper upon the Yellow Fever Germ, calling attention to the absurd newspaper articles upon this subject.

Dr. Hensoldt addressed the Society on "The Larva of *Attagenus pellio*, and its wonderful armor," illustrating his remarks by diagrams on the black-board. This Address is published in this number of the Journal, p. 34.

OBJECTS EXHIBITED.

1. Arrow-hairs of the larva of *Attagenus pellio:* by H. Hensoldt.

2. Endomorphs in sections of vitreous rocks and artificial slags: by H. Hensoldt.

3. Arrow-hairs of the larva of *Mycetophagus:* by Chas. F. Cox.

4. Skin of Northern Fur Seal, *Challorhinus ursinus*, L., showing the fur, growing in bundles and inserted in pockets: by J. L. Zabriskie.

5. Transverse section of skin of the Northern Fur Seal, showing the roots of the hairs in the pockets: by J. L. Zabriskie.

6. Organ of sense in antenna of *Musca:* by L. Riederer.

7. Hair of Mouse, polarized: by Edgar J. Wright.

8. Pond-life; larva of *Corethra plumicornis* and *Conochilus volvox:* by Stephen Helm.

OBJECTS FROM THE SOCIETY'S CABINET.

9. Orthodinitrodiphenylamine.

10. Dimethylamidoazobenzene.

Mr. Zabriskie donated both slides of his exhibit to the Cabinet of the Society.

Meeting of October 19th, 1888.

In the absence of the President and Vice-President, Mr. J. D. Hyatt was elected President *pro tem.*

Eighteen persons present.

Mr. Henry C. Bennett was elected a Resident Member of the Society.

OBJECTS EXHIBITED.

1. Mouth-parts of Ants: by L. Riederer.
2. Twisted hairs, from abdominal rings of a Wasp: by L. Riederer.
3. The fungus, *Chætomium comatum*, Fr.: by J. L. Zabriskie.
4. The fungus, *Echinobotryum atrum*, Cd., parasite on *Chætomium comatum*, Fr.: by J. L. Zabriskie.
5. Crystals of Butter, polarized: by E. J. Wright.
6. Pond-life, *Hydra viridis*, *H. vulgaris*, *Melicerta ringens*, *Rotifer vulgaris*, and the fungus *Botrytis bassiana* on *Nitella*: by Stephen Helm.
7. The foraminifer, *Orbitolites*, from Bermuda: by K. F. Junor.
8. A fossil Bird's Egg, from Bermuda: by K. F. Junor.

Mr. Hyatt suggested for discussion, at some future meeting, the subject, "Intelligence in the lower forms of life, with special reference to the motions of diatoms." He had observed that free, young, growing diatoms, when they meet an insurmountable object, almost immediately reverse their direction of motion.

Mr. Zabriskie said of his exhibits, that the fungus, *Chætomium comatum*, belongs to the black-moulds. He had found his specimens growing upon old buckwheat straw. The perithecium of this species, averaging about one-fiftieth of an inch in diameter, is thin, black and globular; supported on a short, stout pedicel; and thickly studded with dark, rigid, mostly dichotomously branched hairs, which hairs are beautifully ornamented, especially towards their distal extremities, with closely set tubercles. The asci are said to be evanescent. None were found in these specimens. The abundant spores are light-brown, under the microscope, lenticular, and mucronate at both ends.

The fungus, *Echinobotryum atrum*, was found parasitic on the former fungus. The characteristic of the reproductive portion

is the presence of brown, translucent, striated, fibrous threads, seated upon which, at varying distances, are found the radiating, star-shaped clusters of spores. These spores are united at their bases in clusters, and, when separated, are seen to be flask-shaped, with a brown body and translucent neck, having the general surface ornamented with minute tubercles.

Mr. Zabriskie donated both slides to the Cabinet of the Society.

Dr. Junor stated, that the fossil egg, exhibited by him, was obtained from solid rock, at a considerable depth in the rock-formations of Bermuda. Frequently bones of birds and pieces of eggs are found there ; but this was the most perfect fossil egg which had come under his notice.

Dr. Junor donated, for distribution among the members, spines, and portions of the calcareous skeleton, with spines *in situ*, of the echinoderm, *Cidaris ;* foraminiferous sand ; and specimens of the foraminifer, *Orbitolites*, all from Bermuda.

On motion, the following Committee was appointed by the Chair to procure an additional book-case for the Library : Walter H. Mead, William R. Mitchell, and John L. Wall.

Meeting of November 2nd, 1888.

The President, Mr. Charles F. Cox, in the chair.

Thirty-six persons present.

On motion, Dr. N. C. Husted, of Tarrytown, N. Y., was invited to address the Society, at the meeting of December 7th, 1888.

Mr. Charles S. Shultz read a Paper, as announced in the programme, and entitled, "An advertisement in the 'New York World' of October 7th, 1888, entitled, 'A great discovery * * * A microbe microscoped,' &c." This Paper was illustrated by microscopical objects, which were referred to in "The World" as microbes.

OBJECTS EXHIBITED.

1. A group of arranged diatoms, with *Arachnoidiscus Ehrenbergii* in the center this last being the same as shown in the first figure in "The World" advertisement : × 160.

2. *Arachnoidiscus Ehrenbergii*, in its natural condition and *in situ* upon a marine alga : × 40.

3. A group of diatoms, with six of the *Actynoptycus*, being the same as shown in the first figure of the second column of "The World." Also six of the *Triceratium*, being the same as shown by the second and third figures in the same column : × 50.

4. The diatom, *Isthmia enervis*, *in situ* on marine algæ, as an example of the fourth figure in the second column of "The World": × 50.

5. A portion of the tracheal system of a Silk-worm, similar to the last figure in "The World," and said there to be "enlarged one million times": × 30.

These objects, from 1 to 5 inclusive, were exhibited, in illustration of his Paper, read at this meeting, by CHARLES S. SHULTZ.

6. Peridium of the fungus, *Rœstelia aurantiaca*, Peck, from fruit of *Cratægus oxyacantha*, L., English Hawthorn : by J. L. ZABRISKIE.

7. Cells of the peridium and spores of *Rœstelia aurantiaca*, Peck : by J. L. ZABRISKIE.

8. Suctorial disks on the fore leg of *Dytiscus fasciventris* : by J. D. HYATT.

9. Section of the mineral Phonolite, from Berks Co., Pa.: by J. D. HYATT.

10. Crystals of Butter, polarized : by EDGAR J. WRIGHT.

11. A very rare book, "Testacea Microscopica aliaque minuta ex generibus Argonauta et Nautilus ad naturam delineata et descripta a LEOPOLDO A FICHTEL et JO PAULO CAROLO A MOLL. Wien, 1803:" by A. WOODWARD.

Mr. Zabriskie stated concerning his exhibits, that the fungus, *Rœstelia aurantiaca*, is related to the cluster-cups, and is found upon the Apple, the Quince, the Service Berry, *Amelanchier Canadensis*, and the English Hawthorn, *Cratægus oxyacantha*. He found it seventeen years ago, in 1871, near Albany, upon fruit of *Amelanchier*, and it was found during the same year by Prof. Charles H. Peck, and the late Hon. G. W. Clinton. It has been abundant this present year upon fruit of the Hawthorn at Flatbush, Long Island. It is described by Prof. Peck in the 25th Report of the N. Y. State Museum, p. 91. It is interesting because of its own elegant appearance, and because of

the discussion concerning the heterœcism of related species with the fungus, *Gymnosporangium* (Cedar-apple), found upon our Red Cedar, *Juniperus Virginiana*, L. (See Farlow, Halstead and Thaxter.)

Under the attack of this fungus the fruit of the Hawthorn becomes swollen and distorted, and the peridia finally burst through the cuticle, sometimes in such abundance as to cause the fruit to appear like a white, woolly ball. The first slide shows one of these peridia entire, cut from the fruit with a portion of the outer rind still adhering. The base of the peridium within the fruit is bulbous, and is here laid open, showing the spores within. The peridia are white, slender, fragile tubes, frequently one-sixteenth of an inch in length, and soon become lacerated and broken down ; but when young and fresh they are entirely filled with the bright orange-colored spores. The walls of the peridia are composed of a single layer of large, mostly lozenge-shaped cells, ornamented with irregular white ridges, enclosing darker spaces. The spores are large, subglobose, furnished with a very thick hyaline epispore, this latter being elegantly marked with delicate radiating lines.

Mr. Zabriskie donated both slides to the Cabinet of the Society.

Mr. Woodward remarked concerning the volume exhibited by him, that it is printed in Latin and German, with colored plates, and that its descriptions of foraminifera hold good to this day.

Mr. Wright said, that the crystals of butter of his exhibit were obtained by boiling the butter for a long time, and cooling it very slowly. The cross shown in the preparation by the polariscope was very distinct in the center, but indistinct at the extremities.

Meeting of November 16th, 1888.

The President, Mr. Charles F. Cox, in the chair.

Twenty-four persons present.

OBJECTS EXHIBITED.

1. Ovipositor of *Tremex columba*, L., The Pigeon Borer ; polarized : by J. L. Zabriskie.

2. An insect-case, containing *Tremex columba*, L., male and

female, and parasites of the same; *Thalessa atrata*, Fab., male and female; and *T. lunator*, Fab., male and female: by J. L. ZABRISKIE.

3. Pond-life; *Plumatella repens*, and *Floscularia ornata:* by STEPHEN HELM.

4. An unknown and curious form of insect-life, found upon grass in New Jersey: by JAMES WALKER.

5. A piece of felted fungoid mycelium, an inch thick, found on the floor of a wine-cellar at Newburgh, N. Y.: by F. W. LEGGETT.

6. Section of Peridotyte, with transparent, yellow Olivine: by T. B. BRIGGS.

7. Foot of the fly, *Eristalis tenax:* by L. RIEDERER.

8. Sections of the foot-cushions of the same: by L. RIEDERER.

9. Sections of spines of *Echinus:* by J. D. HYATT.

Mr. Hyatt described his method of preparing sections of spines of *Echinus*, saying, that it is much easier to grind down a number of such sections at one time, than to grind one singly. He fills a glass tube with spines, cementing them in place with balsam, and then, by means of a circular diamond-saw, slices both tube and contained spines into thin disks. A number of these disks are cemented by balsam to a glass slip, and all are ground down together. In order to successfully turn them over, to continue the grinding, they are cemented to the first slip with thin balsam. The slip, to which they are to be transferred, is supplied with thick balsam and inverted over the sections, whereupon, with proper manipulation, the sections will leave the first slip and adhere to the second. He mounts seven or eight sections of spines under one cover, returning them to their desired positions, if displaced in mounting, by inserting under the cover a needle, ground flat and very thin upon an emery-wheel.

Mr. Zabriskie said, that the insect, from which his exhibit was taken, was captured ovipositing in the hard, decorticated wood of a standing Silver Maple, *Acer dasycarpum*, Ehrh. The ovipositor was inserted about one-half of an inch into the wood, and it required considerable force and much patience with the help of a forceps to extract it, without entirely demolishing the ovipositor. Even with the greatest care the terminal barbs were somewhat injured by the operation. The shaft and the depressions between the barbs of this ovipositor polarize brilliantly.

He also remarked upon the curious manner of oviposition by the long stinged parasites, *Thalessa atrata* and *T. lunator*, which remarks were supplemented by interesting items of information by Mr. Beüttenmuller. (See also Prof. J. A. Lintner in Fourth Rep. N. Y. State Entomologist (1888), p. 36.)

Mr. Stephen Helm said, that he kept the specimens exhibited by him alive in an aquarium for months in succession ; and that it will be found that shading an aquarium tends to prolong the life of its inhabitants.

Mr. Helm also said, that he had lately found *Volvox globator* in exceeding abundance in the stream, at the pumping station of the Water Works, Flatbush, Long Island.

Meeting of December 7th, 1888.

The President, Mr. Charles F. Cox, in the chair.

Fifty-five persons present.

Mr. Gilbert H. Crawford, and Prof. Louis H. Laudy, Ph. D., were elected Resident Members of the Society.

The President appointed the following Committee on the Annual Reception : Walter H. Mead, J. D. Hyatt, and William Wales.

The President also appointed the following Committee on Nomination of Officers for the ensuing year : F. W. Devoe, F. W. Leggett, and George F. Kunz.

OBJECTS EXHIBITED.

1. Mycelium of the fungus, *Agaricus campanella*, on White Cedar : by P. H. Dudley.
2. The Beetle, *Zopherus Mexicanus*, Sol. : by F. W. Devoe.
3. Metal chips cut by the same : by F. W. Devoe.
4. Slides of Diatoms, arranged by Prof. Tooms : by K. M. Cunningham.

Mr. Cunningham explained his method of mounting diatoms, and donated diatomaceous earth, from the new Railroad cutting in Richmond, Va., for distribution among the members.

According to the announcement in the Programme, a Paper was read by Dr. N. C. Husted, entitled "Hay-Fever : its treatment physiologically and pathologically considered." This Paper was illustrated by a colored diagram of nerves of the

human head, elicited interesting discussion, and is published in this number of the JOURNAL, p. 26.

On motion, the thanks of the Society were tendered Dr. Husted for this interesting Paper.

The President informed the Society, that the specimen of Gamboge, rubbed up in water, which he had prepared August 3d, 1874, which had until recently shown very active Brownian movements, and which he had exhibited at the last Annual Reception, seemed at last to have ceased its activity, a leak having developed in the enclosing cell, and evaporation having ensued as a consequence. He thought the subject would be of interest to the Society, as fourteen years was probably the longest period during which this phenomenon had been under observation.

PUBLICATIONS RECEIVED.

The Microscope : Vol. VIII., Nos. 9–12 (September–December, 1888).

The Microscopical Bulletin and Science News: Vol. V., No. 5 (October, 1888).

Anthony's Photographic Bulletin : Vol. XIX., Nos. 17–24 (September 8–December 22, 1888).

Bulletin of the Torrey Botanical Club : Vol. XV., Nos. 6, 10–12 (June, October–December, 1888).

The Botanical Gazette : Vol. XIII., Nos. 9–12 (September–December, 1888).

Entomologica Americana : Vol. IV., Nos. 1–9—Vol. V., No. 1 (September, 1888–January, 1889).

Proceedings of the Natural Science Association of Staten Island : Meetings of September 8–December 8, 1888.

Journal of Mycology : Vol. IV., Nos. 8–11 (August–November, 1888).

Psyche : Vol. V., Nos. 149–152 (September–December, 1888).

The Swiss Cross : Vol. IV., Nos. 4–6 (October–December, 1888).

Transactions of the New York Academy of Sciences : Vol. VII., Nos. 7, 8 (April, May, 1888).

The School of Mines Quarterly : Vol. X., No. 1 (November, 1888).

Proceedings of the Academy of Natural Sciences of Philadelphia: 1888, Part II.

Proceedings of the Newport Natural History Society : 1887–1888, Document 6.

Journal of the Cincinnati Society of Natural History : Vol. XI., Nos. 2, 3 (July–October, 1888).

Journal of the Elisha Mitchell Scientific Society : Vol. V., Parts 1, 2, (January–December, 1888).

Agricultural College of Michigan : Bulletin No. 39 (September, 1888).

The West American Scientist : Vol. V., Nos. 1, 2 (September, October, 1888).

The Electrical Engineer : Vol. VII., No. 77 ; Extra ; Nos. 82–84 ; Vol. VIII., No. 85 (May, September–December, 1888 ; January, 1889).

The Brooklyn Medical Journal : Vol. II., Nos. 9–12 (September–December, 1888).

The American Lancet : Vol. XII., Nos. 10–12 (October–December, 1888).

The Pacific Record of Medicine and Surgery : Vol. II., No. 10 ; Vol. III., Nos. 2–5 (May 15, September 15–December 15, 1888).

The National Druggist : Vol. XII., Nos. 6–12 ; Vol. XIV., No. 1 (September 15–December 15, 1888 ; January 1, 1889).

The Rocky Mountain Druggist : Vol. I., Nos. 6–9 (September–December, 1888).

Mining and Scientific Review : Vol. XXI., Nos. 11–26 (September 27–December 27, 1888).

Indiana Medical Record : Vol. VII., Nos. 4–6 (October–December, 1888).

The Satellite : Vol. I., Nos. 1, 4 ; Vol. II., No. 2 (August, 1887 ; May, November, 1888).

The Exchanger's Monthly: Vol. IV., No. 1 (November, 1888).

The Hahnemannian Monthly: Vol. XXIII., Nos. 10–12—Vol. XXIV., No. 1 (October, 1888—January 1889).

Smithsonian Report: 1885, Part II.

Journal of the Royal Microscopical Society: 1888, Parts 5, 6.

Journal of Microscopy and Natural Science: Vol. I., Part 4 (October, 1888).

Grevillea: Vol. XVII., No. 82 (December, 1888).

North Staffordshire Naturalists' Field Club: Annual Report, 1888.

The Naturalist: Nos. 159–161 (October–December, 1888).

Proceedings of the Canadian Institute: Vol. XXIV., No. 50 (October, 1888).

The Canadian Record of Science: Vol. III., No. 4 (October, 1888).

Field Naturalist's Club of Victoria: Eighth Annual Report (1887–8).

The Victorian Naturalist: Vol. V., Nos. 4–6 (August–October, 1888).

The Ottawa Naturalist: Vol. II., Nos. 3–7 (June–October, 1888).

Cornell University College of Agriculture: Bulletin No. 2 (August, 1888.)

Société Belge de Microscopie: Bulletin, Vol. XIV., Nos. 8–9 (1888–9).

Société Royale de Botanique de Belgique: Comptes-rendus (October 13, November 10, 1888).

Société des Naturalistes de Kiew: Memoir, Vol. IX., Parts 1, 2 (1888).

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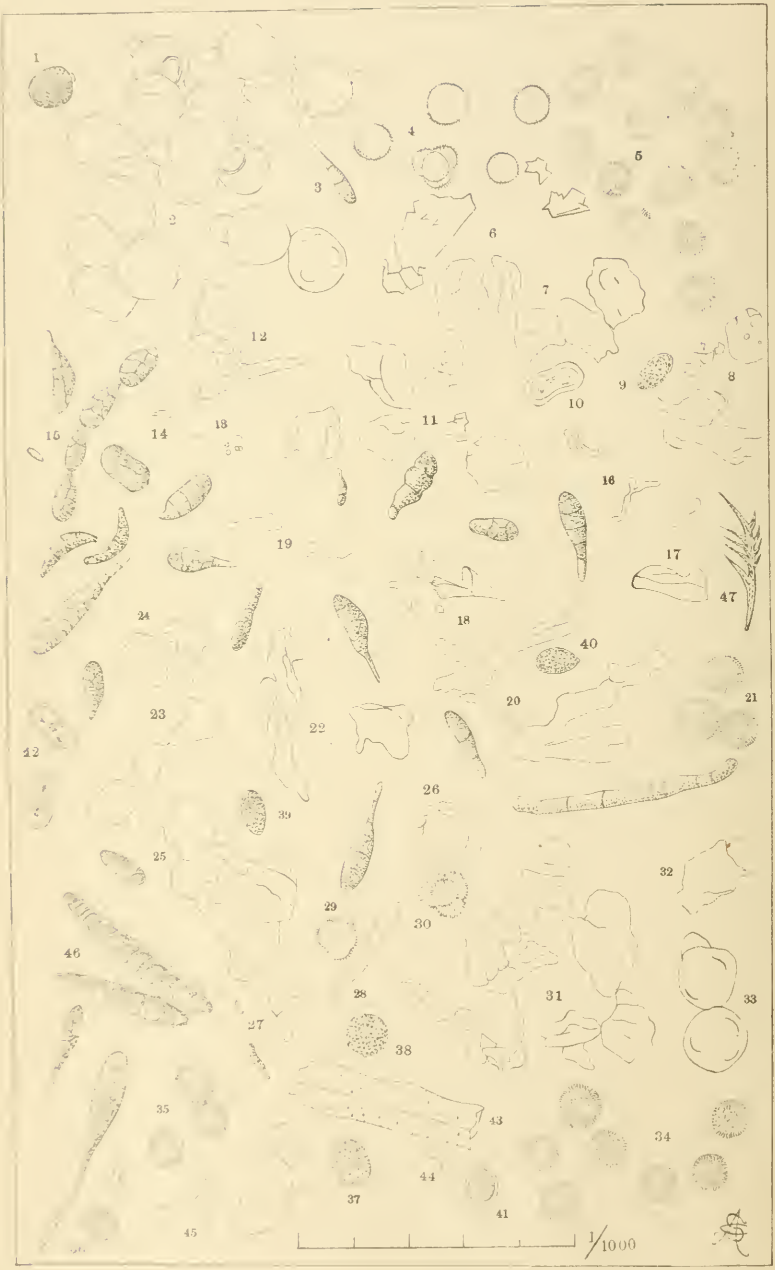

LOCKWOOD ON COMPARATIVE HYGIENE OF THE ATMOSPHERE.

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THE COMPARATIVE HYGIENE OF THE ATMOSPHERE IN RELATION TO HAY-FEVER.

BY SAMUEL LOCKWOOD, PH. D.

(*Read January 18th*, 1889.)

In the middle of August, 1888, in pursuance of a promise to the United States Hay-Fever Association, I began some work in an effort to determine the relative character of the air in relation to Hay-Fever. My post of observation was Maplewood, N. H., about a mile and a half from Bethlehem, the noted resort for

Explanation of Plate 16.

1, Fungus-spore, with tip of pedicel attached. **2,** A group of smooth pollens, with protuberances. **3,** A fungus-spore. **4,** Five figures of spinous pollens. **5,** A group of twelve pollens of Ragweed. **6,** Two of the frequent mineral particles. **7,** Five epithelial plant-scales. **8,** Three of the same. **9,** Ovoid fungus-spore. **10,** Fungus-spore, with thick walls. **11,** Four plant-scales, and two mineral flakes with acute angles. **12,** Vegetable fragment. **13,** and perhaps **14,** Minute spores. This impalpable dust, probably the spores of some "smut" or "bunt," was often shown on the slides in groups containing many individuals. **15,** A group of pedicelled fungus-spores. (All the heavily shaded figures, not numbered, are fungus-spores of this character.) **16,** Three fungus-bodies. **17,** A mineral flake. **18,** Six vegetable exuviæ. **19,** Three mineral flakes. **20,** Vegetable exuviæ. **21.** Three pollen-grains. **22, 23, 24, 25,** Epitheloid scale-exuviæ of plants. **26, 27,** Three mineral flakes. **28,** Something vegetable. **29, 30,** Pollen-grains, same as Fig. 4. **31,** Twelve vegetable and mineral scales. (This is from one of the mountain-slides, and is typical of the mountain-catch.) **32,** A mineral flake. **33,** A pair of pollen-grains, identical with pair at the lower right hand side of Fig. 2. **34, 35,** Seven, and three pollen-grains like Fig. 21. **36, 37, 38,** Fungus-spores. (**37,** A side-view. **38,** An end view.) **39, 40,** Fungus-spores. (Probably same as Fig. 9.) **41,** Fungus-spore with thick wall, and teat-like terminus. **42,** Two fungus-spores with walls like Fig. 10. **43,** Vegetable fragment, with fine perforations, frequently occurring. **44,** This and the four forms in **45** show the crystal-like angles of the objects, which are here called epitheloid vegetable-scales. **46,** A pair of teleutospores, that is completed spores, of a *Phragmidium*, or chambered spore, such as occurs in the "brand" or "rust" that attacks the Rose. **47,** A byssus, or vegetable-hair.

NOTE.—These figures are of course elective, the object being to give the most interesting forms. They are taken from only seven slides out of nearly one hundred. Where groups are drawn the objects are in relative position, as they lay on the slides. Group 5 shows twelve pollen-grains in position, and this is taken from a slide containing nearly three hundred pollen-grains, besides innumerable other objects both vegetable and mineral. To exhaust the diversity of forms would need another plate; for not only are many forms of vegetable hairs, and other exuviæ of structure omitted, but also some insect-scales, etc. For this beautiful plate I am indebted to the facile pencil of my friend, Dr. A. C. Stokes, the accomplished infusorist.

persons suffering with this malady. From the 16th of August until the 20th of September, each day when not prevented by rain, three ordinary slides charged with glycerine were set out of doors to catch the foreign contents of the air. Meanwhile, my son under instructions, made similar exposures at our home in Freehold, N. J., whose elevation above mean tide is about 200 feet, and that of Maplewood about 1,500 feet.

While in the White Mountains the catch of each day was studied in the night with the microscope, and notes were duly taken. After my return home, September 21st., the daily exposure of slides was kept up until the 22d of October, when, having for several days failed to catch any pollen, it was discontinued. After having studied the home-slides, I restudied those from the mountains, and finally a patient comparison was made through a number of evenings of both series, the two embracing nearly one hundred slides, of which forty-five were taken at Maplewood. I had hoped to double this number, but the frequent rainy days prevented.

In respect to the two places chosen for observation :—at the home-station the malady exists in the kind and extent so general in the Eastern States, while my mountain-post, with a wide region around, was highly favored as a sanitarium from this ailment. But we must not look for entire exemption, even in the very best of these resorts, unless Nature has been left to her virgin forms and moods. All are somewhat affected, and some even seriously, by the local industries, whether of agriculture, or other industrial pursuits. For those afflicted with the severe forms of this disease, complete immunity is not possible where the air is charged with the mineral debris and vegetable effluvium, which elsewhere prove irritants to the respiratory passages of persons who are pathologically susceptible. Even in these, the most highly favored places of the White Mountains, at the time of the flowering of the grasses, and cutting of hay, which is usually over when the summer guests have come, there are sporadic cases of Hay-Fever among the natives. These seem to be of the type known as June, or Rose Cold. The main irritant is the dust and pollen of the Timothy, or Herd's-Grass, *Phleum pratense*, and probably in a less degree of the wild Herd's-Grass, *P. alpinum*.

When the south winds prevail there is invariably an increase

of suffering among the hay-fever subjects at the retreats we are dealing with. These winds bring up from the valleys of the Saco and the Connecticut the fine plant dust and pollen, chiefly that of the Ragweed. But a fact often overlooked is the acute distress caused to the super-sensitiveness, or so-called hyperæsthesia of the intra-nasal, and respiratory passages, by any kind of dust, even the effluvia of fruit, and the odor of flowers, and domestic animals, especially horses. In some of these mountain retreats so excellently conducted, one sometimes finds a certain æsthetic taste, without the sanitary judgment. Bouquets on the tables and festoons of Lycopodium, however prettily they set off a room, are to the subject of Æstivis torture in disguise.

As affecting Hay-Fever the flora of the White Mountains is less deleterious than that of many other regions. The wet places produce the large Bull-rush, or Cat-tail, *Typha latifolia.* Ladies will buy these showy objects of the boys to decorate their bed-rooms, thus unconsciously inviting nights of suffering. The most notable native flowers are two Spiræas, the purple Hardhack, *Spiræa tomentosa*, and the white Spiræa, *S. salicifolia.* The Goldenrod is quite prevalent in a number of species, the commonest being *Solidago altissimum.* This fine plant creeps up the mountains, with the Ferns taking possession of any untimbered spot, and also asserting itself on the road-sides, with the showy Aster, *A. Novæ-Angliæ.* To these we may add the Northern Fire-weed, or Great Willow-herb, *Epilobium angustifolium*, and the tall Butter-cup, *Ranunculus acris.* These, I think, sufficiently complete the list for the purpose of our inquiry. They all keep in bloom until the frost arrests them. It is observable that every one of these plants seeks cleared or tilled localities. As yet the Rag-weed, *Ambrosia artemisiæfolia*, is an innovator, being only found at the railroad stations, where it is doing its best to obtain a start. It was supposable that my catch of pollen on the slides would be from these plants, with possibly, when the south-wind prevailed, some from the Ragweed of the valleys south.

The catch of my aerial traps proved a surprise. Of the nearly fifty slides only two showed any pollen whatever. One contained, with some mineral particles and vegetable fibres, five grains of Aster pollen, and another, with like associations, had three grains of pollen of Spiræa. The slides however were inter-

esting. They all contained more or less vegetable debris, sometimes as simple fibre, but oftener in exceedingly fine scales, the margins often showing well-defined geometric lines, and almost suggesting epithelial scales. These would be commingled with minute particles of wood, and mineral dust, the last prevailing. There would occasionally be a lepidopterous scale from an extremely minute Tineidæ Moth. I found also some vegetable hairs, which polarized with fine effect. It should be mentioned that these objects, animal, vegetable, ligneous and mineral were, as a rule, utterly invisible to the unaided eye.

A special word seems needed for the ligneous particles. No artificial section can quite compare with some of these minute ligneous abrasions. They are so delicate that the pitted cells, which indicate their coniferous nature, are left in fine relief. A section at best can only give us these cells with the other tissue embedded between, but these look clear and separate, as if the tissue had been peeled off, leaving the round cells in rows, distinct as the peas in a pod. In like distinctness too, is shown the spiral tissue. Under the polariscope these bits of wood, as if they might be fortuitous preparations, are very elegant objects. The pitted cells look like tiny buttons of brilliant ruby, while the spiral tissue, blue as azure, seems to bind together fascines of delicate rods of gold. From Maplewood to Bethlehem, for over a mile in length, is a wooden walk ; and little think the fair pedestrians that the abrasion by their feet gives to the microscopist lignean dissections of such exquisite delicacy.

In the home-slides I think the mineral matter was generally a little coarser than that in the mountains. But it was greater in amount, a fact to be expected, since in both places it is chiefly road-dust, and in or near an old busy town one should expect the quantity to be the greater. There is, however, a striking difference between the vegetable catch of the two places. The fibrous debris and the subtile exuviæ of scales and cells, the almost impalpable plant-dust is more plentiful, and the pollen deposit incomparably greater. I have counted from two to three hundred pollen-grains of Ragweed on one of these home-slides. The amount would vary with the character of the day —being, of course, the greater on dry days.

This ragweed-pollen had to be borne some little distance, as pains have been taken to extirpate the weed in my vicinity. It

was interesting to note the tendency, so to speak, of affinity, for the grains lay on the slides associated in groups, from pairs and triplets and quartets up to thirty in a cluster. It was interesting to notice that one slide indicated a fine streak in the air, in the way the grains lay on the entrapping medium. Of course, usually they lay scattered, and mingled with the other debris. There were also tiny bits or patches of tissue, suggestive of the lining membrane of some anthers. On one slide I found a group of twenty-four pollens, some of which had protuberances, varying from one to three on a pollen-grain. They looked like *Epilobium*, but without comparative material I can not identify them. As some of these grains are without the protuberance, I am inclined to regard these excrescences as the protrusion of the fertilizing tubules, due to the effect of contact with the glycerine. These appearances are correctly given in the plate. The *kinds* of pollen caught were very few. The ubiquitous presence was the pollen of the Ragweed. In truth it was surprising how this one pollen dominated the occupancy of the air.

I have mentioned the presence of vegetable hairs, so extremely minute as to be invisible to the unaided sight. In the home-specimens these were cylindrical and jointed, not unlike the Bamboo, but they tapered at each end to a point of exquisite fineness. I think a few of these in the respiratory passages of a hay-fever subject must be very irritating.

Exceedingly interesting were certain minute bodies, which were recognized as fungus-spores. Some were in the form of Indian clubs, others like tiny barrels, others again were curved like the fruit of the banana. Other forms were so minute, that, like the spores of some of the Mosses, five or six could be contained in the space occupied by the one tiny pollen of Ragweed. So distinct from each other were many of these spores that I was tempted to believe I could distinguish some of the forms resulting in the same species from the curious phenomena of the alternation of generations, so often manifested in the life-history of one of these lowly plants, known as rust, smut or mould. I think these fungus-spores came from the village shade-tress, the fruit-orchards and vineyards.

I was somewhat surprised to find that while the October catch at the beginning of the month contained a few pollens, and these of Ragweed, it soon ceased to show any. This

recalled an experience just a year before. Wishing to obtain some ragweed pollen for the microscope, I was disappointed in finding the material scarcer, and a change in the form or condition of the pollen-grains. They were less spherical and less spinous. In a word, less like a tiny chestnut-bur. This may be noticed in my figures in the Article, "The Pathology of Pollen in Hay-Fever," my only specimens to draw from being a few late, or October pollens.

Conclusion.—Let us epitomize these differences in our home-catch, and that in the mountains.

1. The place of observation in both instances was along a much-travelled road, yet the air at home contained more and slightly coarser mineral matter.

2. The general vegetable debris, composed of fibres, the dust of exuviation, such as plant-cells, scales etc., was in greater quantity at home. But, then, this is the center of a busy agricultural industry.

3. In the New Jersey "catch" the vegetable debris contained in the air, both in kind and quantity, exceeds very greatly that of my retreat in the mountains. The interesting fact, too is the marked presence of fungus-spores in the home-atmosphere.

4. We have next the fact of the great quantity of pollen in the air at home. Also this notable fact that the great preponderance of pollen is that of the Ragweed. This plant also gives off a large amount of dust, which we may suppose to be like the pollen, acrid and toxic. I think we may admit that this plant deserves its bad reputation as the worst foe of the hay-fever subject. It is the irritant preëminent.

5. The fact is significant, that the greater catches for quantity and quality occur in August and September. The pollen-grains of October are fewer, and functionally feebler. The spines then on the ragweed-pollen are almost abortive.

The summer air of the White Mountains is less heated than at home. I should think the daily average difference would be fully ten degrees. It is also much drier, hence delightfully bracing. I know nothing of any scientific experimentation on the chemistry of the air of these regions, but I think it cannot be otherwise than that it receives a terebinthine effect from the balsams, which clothe the mountains. Hence, from the three factors here mentioned, the air should be markedly tonic. If

then to these be added the smaller quantity of vegetable exuviæ and the comparative absence of pollen—that is the small amount present, and the kind—I believe, practically, we have the hygiene of these mountain sanitaria as affects the question of relative exemption from Hay-Fever.

THE TERMITES, OR SO-CALLED "WHITE ANTS" OF THE ISTHMUS OF PANAMA.

BY P. H. DUDLEY, C. E.

(*Read December 21st*, 1888.)

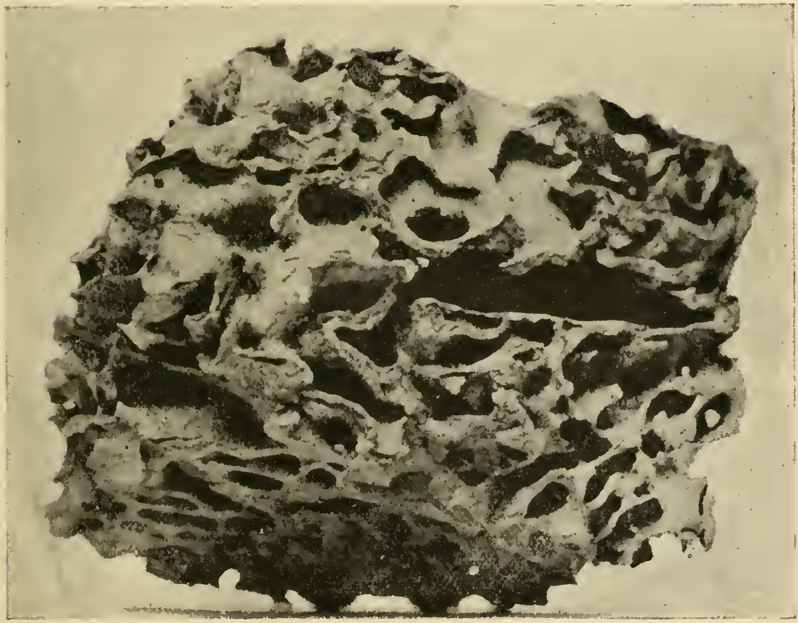
The destruction of wood-work by the Termites in tropical countries, especially where great humidity exists, is well known to you all. The fact does not make so much impression upon us at this distance, as it does when we go and see the evidences of their destruction. Structures made from the softer woods can be readily eaten, while those made from the harder woods can be eaten as soon as the tissues are softened by decay, caused by the rapid growth of fungi.

How to protect the wood of buildings, cars, furniture, and other structures from the combined attacks of Termites and fungi is a complicated problem in many tropical countries. In many portions of India the English, in building railways, found the destruction of ties so rapid, even after treatment to check decay, that metal was substituted for wood. Several engineers, who were employed on the Indian railways, in describing the destruction of ties to me, attributed it mostly to the Termites. I should qualify that opinion to some extent, and think the growth of fungi had much to do with the rapid destruction of ties, notwithstanding their treatment. The treatment of wood for use in tropical countries, must be much more thorough than that for service in colder countries. The fibres of the entire stick must be treated.[1]

[1] Since this Paper was read Mr. Frank Passmore, Civil Engineer of London, formerly in charge of the construction of some of the Indian railways, called upon me. He said, with regard to the destruction of sleepers by the Termites on the Indian railways under his charge, "The sleepers were creosoted in London. The creosote only penetrated from one-half to one inch in the sides of the sleepers. On the ends the penetration was much greater. The ties failed by the decay of the internal, untreated portions, and the attacks of Termites, the latter entering through some crevice of the treated wood to those portions which were untreated, soon rendering them unserviceable."

Explanation of Plate 17.

Fragment cut from interior of nest of *Eutermes*, showing transverse section of queen-cell, and also sections of numerous passages for the workers. (Natural size.)



DUDLEY ON TERMITES.

Eight species of Termites have been found upon the Isthmus of Panama—three genera being represented, viz.: *Calotermes*, *Termes* and *Eutermes*. According to Dr. H. Hagen *Eutermes* is considered a sub-genus of *Termes*, owing to a peculiar venation of the wing. There is great confusion in this classification as applied to the species from the Isthmus. It puts species, having soldiers with powerful mandibles, in the same genus with species, having soldiers with a long beak. Upon the Isthmus, the nests of the species having long beaks are so distinct in

Fig. 1.—Nests of *Eutermes*. Parent-nest on the trunk of a palm in the centre, containing ten queens, and having two galleries conducting to the ground. Supplemental nests, one on either side, containing no queens, but abounding with eggs and young.

character, from those of the species having soldiers with long mandibles, that it hardly seems possible for them to belong to the same genus. In describing the work of the different species, those having soldiers with long beaks will be called *Eutermes* in this Paper.

In the United States three species of Termites have been found, *Termes flavipes*, Kollar, being the most common. Its attacks in this latitude are confined to books, and wood undergoing decay, it being especially fond of white-cedar hop-poles. Dr. Hagen says the queen of this species has not been found.

The soldiers are armed with curved mandibles, which they can open at the points fully one-sixteenth of an inch, and when they are closed upon a common ant with a quick blow, they cut the ant in twain. The inner sharp edges of these mandibles are finely serrated. The soldiers and workers of this species are wingless and blind.

Five of the species from the Isthmus have soldiers with powerful mandibles, somewhat similar to those of *Termes flavipes.* The queens of none of these species have been found upon the

FIG. 2.—Nest of *Eutermes* in crotch of tree, six feet from the ground, containing four queens. Supplemental nest at base of same tree, with no queen, but abundant eggs, workers, nasuti and winged specimens.

Isthmus at the present writing. One feature of the heads of the soldiers is the strong protecting envelope of chitine over the great developement of muscles to work the mandibles. These species, with one exception, have been collected in the wood they were eating, or taken from their nests and covered galleries. One species builds a conical earth, or mud nest. That from which the specimens were obtained was twenty inches high, and of the same diameter at the surface of the ground. The nest also extended below ground. In searching for the queen-cell the nest was cut down from the top, and excavated for an equal distance below the surface of the ground without reaching the

bottom. Neither the queen nor her cell was found.[2]

Calotermes marginipennis (?) seems to be a very aristocratic species, and has only been found in the ash door-posts of first-class coaches, which were in daily service. Nothing indicating a nest has been found. The wood is eaten out, after gaining access to the interior of the post, but not re-filled, as is often the case with species of *Termes*.

The three other species from the Isthmus have nasuti soldiers, or those with beaks, which in this Paper will be called *Eutermes*.

Many nests and queens have been obtained of these, which are very abundant upon the Isthmus. Small portions of several nests showing the cell-structure, and especially the queen-cells, are before you. The cells, and, in many cases, the passages in the nest are very irregular, and seem intended more to give strength to the surrounding structure than regularity of passage. The walls at first are thin, but are thickened by accretions as the nest becomes older and larger. The nests which I saw were attached to small trees, from four to ten feet above the ground. Others were reported to me which were from fifty to sixty feet from the ground. The nests which I saw were from ten to thirty inches in diameter, and looked like large excrescences upon the trees. Some of them were pear-shaped, others were globular, excepting on the side of attachment. On a small tree, not over two or three inches in diameter, the nest was usually symmetrical. The cells in the nest were covered by a thin layer of the same material as that forming the nest, having very minute raised apertures, preventing the ingress of rain, but allowing ventilation. The entrance and exit to the nests were by covered galleries, one gallery often serving for both entrance and exit.

The system of galleries of the Termites, especially of *Eutermes*, forms a conspicuous and important feature of these structures upon the Isthmus. The galleries extend from the nest to places where food can be obtained, or more properly to some wood to be eaten. Some of these galleries extend two hundred feet from the parent nest, and through them the lines of workers

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[2] Advices, of January 14th, 1889, state that the nest, after being cut down upon one side, was abandoned by the occupants, and all trace of them was lost. A second mud nest three and one-half feet in diameter and of the same height, has been found at Corozal station, three miles from Panama.

pass to and fro. Blind soldiers are stationed in the galleries in case of a break to guard it and to call the workers to repair the breach.

The *Eutermes* quickly construct nests in buildings, or in unused cars. The largest specimen of a nest here exhibited is from a freight-car, which had been standing on a siding for a few months, and was attacked by the *Eutermes* and rendered useless. They constructed their galleries up the wheels from the ground, and so gained access to the wood-work of the car,

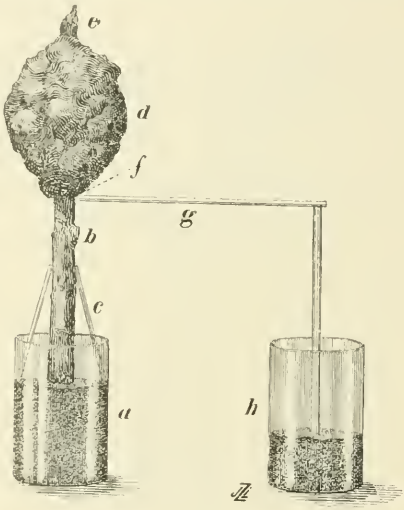


FIG. 3.—Mr. J. Beaumont's "*Ne plus ultra* Termitarium." ***a,*** glass jar, six by nine inches, two-thirds filled with soil; ***b,*** trunk of a small tree, two inches in diameter, which the Termites had surrounded with a globular nest; fixed in the centre of the soil, and measuring eighteen inches from the bottom of the jar to the bottom of the nest; ***c,*** one of two braces steadying the nest; ***d,*** nest, ten and one-half inches long; ***e,*** eroded upper portion of tree, projecting through nest; ***f,*** breach made in nest; ***g,*** bridge leading from breach; ***h,*** "annex jar," one-third filled with soil. When in use the jars stand in bowls partly filled with water.

which was so completely tunnelled that it was rendered unsafe. This was undoubtedly an auxilliary nest, as no queen-cell was found. It is not uncommon to find two or three auxilliary nests, with young but no queen-cells, near the parental nest.

Examination of the queen-cells shows, that while, in some respects, they are similar in the slight arching and height of the roof from the floor, they still vary greatly in length and breadth. The largest queen of *Eutermes*, so far found upon the Isthmus,

is one and one-quarter inches long, and five-sixteenths of an inch in diameter. Many of the mature queens are not over seven-eighths of an inch long, and from three-sixteenths to one-quarter of an inch in diameter. Some of the queen-cells contain only one queen, while in others there are two or more—ten being the greatest number found in one cell. The numerous passages leading into the queen-cells are only sufficient in size for the entrance and exit of the workers. Before the queens have reached maturity they can run through the nest, but afterwards they cannot leave the royal chamber. In one of the queen-cells, from a nest near the beach, minute fragments of coral had been incorporated in the primary walls of the cell. These walls were afterwards thickened with deposits, as in the case of the other specimens. The substance of the cells, which generally seems to be comminuted wood mixed with some cement, becomes very hard and firm, and takes a good polish like papier-maché.

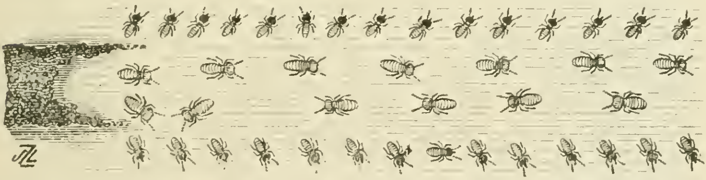


FIG. 4.—(Natural size.) A small portion of a double line of *Eutermes* soldiers (nasuti) enclosing and guarding workers while building a gallery upon the bridge of the "Termitarium." (Fig. 3.)

The *Eutermes* live in large communities—the members consisting of males, females, soldiers and workers. The males and females have eyes and wings, and before the swarming season exist in the nest in large numbers. After swarming their wings drop off, and numbers of the insects perish. A few of the females return to the nest to become the future queens of the community, or to found new colonies.

The soldiers of the *Eutermes* are, to say the least, unique. Instead of being armed with strong mandibles each one is equipped more in accordance with modern ideas of warfare, and carries a gun, quite as wonderful as the Winchester repeating rifle. The head is pear-shaped, anteriorly produced into a long nose, from the point of which extends, back into the head, a

tube connecting with a magazine surrounded with strong muscles, for firing an offensive glutinous shot, which puts an antagonist twice his size hors de combat. One of these wonderful soldiers is shown as object No. 30, while Nos. 31 and 32 are sections through the head showing the tube, muscles and the cerebellum.

FIG. 5.—*Eutermes* soldiers (*nasuti*) guarding workers while repairing a breach in a gallery. (Natural size.)

The workers perform the entire labor of the community. They eat the wood, excavate the tunnels therein, construct the nests and galleries, prepare the food for the young and the queens—feeding the former for a time, and the latter continuously. Some of them are in constant attendance to gather up the queens' eggs, and to distribute them in the cells for hatching. Like the soldiers, the workers are blind. Picking up an egg, less than one-fiftieth of an inch in length, in the dark, is but one of the many wonders they can do. They have some specialized sense, so acute that it makes up for the absence of eyes. On the Isthmus, unless the nest or galleries are broken into, the workers and soldiers are rarely seen. They do not swarm with the males and females.

The galleries are dark, and the light is cut off when they are tunnelling the wood, which they are very careful not to cut through to the surface, so their work is not noticed. A bureau, standing against the wall of a room over two weeks, will often be attacked—the wood-work of the drawers so completely tunnelled, that one vigorous pull will cause them to fall in pieces. A breach in a gallery will be repaired in the day-time, but the extension of the galleries seems to be done during the night.

The worker is provided with short and stout mandibles, for cutting and tearing the wood. Each mandible, anteriorly, has a short curved point or tooth, and immediately back of this is a second tooth. The species. however, are not all alike in this respect. When the mandibles are closed, the projections of one shut into the indentations of the other. Posteriorly the mandibles have a series of dentitions, used for reducing or masti-

cating the detached wood, which is further reduced to pulp in the gizzard. They eat the wood for sustenance, as it is found in the alimentary canal, giving this the color of the wood eaten —light colored if the wood is clear and white ; dark if the wood is red.

On the Isthmus there is so much more moisture in the air than here, that many of our seasoned woods, which here contain only from twelve to eighteen per cent. of moisture, will reabsorb more and become nearly as soft as green woods. And in this condition they can be more easily eaten by the Termites. This is especially true of White Ash, one of our hard and valuable woods here, but worthless there. The large ducts, which constitute the spring growth of this wood, render it especially easy for the Termites to eat, and it is quickly attacked. In specimens, Nos. 21, 22, 23 and 24 it will be seen how the attacked wood is tunnelled without defacing the exterior. It requires close attention for detection. Our common Whitewood is so open grained that it also is quickly attacked. White Pine is only used in thin boards, but it quickly decays on the Isthmus, and, of course, is then attacked by the Termites. Yellow Pine is attacked as soon as the fibres are softened by decay. Spanish Cedar, which is allied to Mahogany, has a strong and pungent odor, and it is said to be exempt from these attacks. This wood is used for the floors and interior finish of houses in many parts of South America on this account.

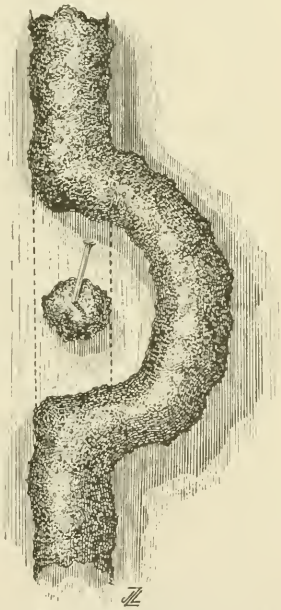


FIG. 6.—Repaired gallery of *Eutermes*. Dotted lines show where the gallery was broken away. The central globular mass, an ant, pinned in position for experiment, and entombed with cemented material by the workers. The curved portion on the right, a new continuation of the gallery built around the obstruction. (Natural size.)

The construction and repairing of the galleries, already mentioned, is performed by the workers, guarded, and in one sense directed by the soldiers. The galleries examined were constructed of minute pellets of clay, sand or small particles of

substances, which were laid in cement. When the latter hardens, it binds the bricks into a firm structure. The operation of setting these pellets seems almost incredible. When a breach is made in a gallery a few soldiers—Nasuti—rush out to guard the gallery against the intrusion of invaders, while others rush off to notify the workers to come and repair the breach. A worker comes, not to see what is to be done, but with his brick in his mandibles, and sets it on the edge of the broken gallery—firmly, and with precision—by a few movements of his head, without line, plummet or square. Being a master-workman he possesses both precision and delicacy of touch, and does not require the implements of man to test the correctness of his work. After he has laid the brick, has he finished—ready to descend for another pellet? Not by any means. He is too careful a builder—not building a house of sand; but he must provide against the fury of the elements. He turns around, and from one of two appendages, near the posterior portion of the abdomen, he ejects a whitish cement on the brick he has laid. In the sun-light the cement turns dark in a few minutes. The appendages I have called eductors, which may be seen, with the special glands for secreting the cement, in object, No. 35. The observations which led to this discovery were undertaken at my suggestion, by Mr. J. Beaumont, Supt. of Motive Power of the Panama Railway, at Colon. Mr. Beaumont soon became so interested in making observations, that he established two termitariums in glass, for the purpose of watching the Termites at work, and has learned more of their habits than has been before reported.

When I was upon the Isthmus, I was very much impressed with the extent of the galleries constructed by the Termites. These galleries serve not only as means of communication, but also as means of protection from the common ants, which destroy the workers of the Termites, if not their soldiers. In a ride down the Chagres, I saw upon several trees, not less than one hundred feet high, Termite galleries, extending from the base up the trunk to the uppermost branches, apparently following each one. At the base, the exterior width of the gallery appeared to be at least five-eighths or three-quarters of an inch, but the galleries did not project from the bark of the tree more than one-fourth or three-eighths of an inch. The galleries

seemed to decrease in size, when near the branches of the tree. Think of the labor involved in carrying up, grain by grain, the pellets to make such a system of galleries! In comparison man hardly executes such undertakings—certainly not without the aid of machinery. Think of the amount of cement, and its waterproof character required to stand a rain-fall of about

FIG. 7.—Method of escape of *Eutermes* from within a glass jar, by coating the inner surface of the glass with cement, ejected from the eductors of the workers; the area of cemented surface being gradually extended during three days, from the soil in the bottom to the upper edge of the jar, where they escaped. *a, a, a,* limit of first day's work; *b, b,* limit of second day's work; *c, c,* the third day's work, the two main tracts uniting at the star, and allowing escape at the upper edge of the jar. (Reduced two-thirds.)

twelve feet per annum! I did not see nests in the trees, on which I noticed the galleries. But I am informed that they sometimes are seen. A decayed branch, however, might have furnished a supply of food.

On the stone walls of the church, built at Colon by the Panama Railway Company, were numerous galleries of the Termites

running to the wood-work of the roof. The latter has been completely tunnelled, and is now being replaced. Breaking the galleries seems to do but little good. They are quickly repaired, or new ones are constructed. In the Panama Railway shops the galleries are broken every Saturday.

Mr. Beaumont has made many observations on the repairs of galleries, one or two of which I will describe, to show how carefully they are guarded. Making a breach in one of about three-quarters of an inch in length, he killed a common ant and pinned it in the middle of the breach. A worker approached it closely, and then ran away. A nasutus soldier then approached, made an examination and ran off. A number of workers came back and cemented the ant fast to the wood. And finally, in repairing the gallery, they ran it around the ant, leaving the latter outside. The soldiers are the last to enter the gallery before it is closed, remaining near the orifice on the inside until the last brick is in place. A breach of one-half to five-eighths of an inch in length has often been repaired in twenty minutes.

Mr. Beaumont, wishing to see them repair a larger breach, made one of about six inches in length. A sufficient number of soldiers came out to form a line in single file on each side of the ruptured gallery, and between the files workers closed up the breach, working from each end, and finishing at the centre.

Another observation worthy of note was in making a breach in a gallery, which ran over a small box. A worker was dislodged and brushed from the box to the ground. He ran up the side of the box, and found the gallery some six inches from the breach, which he did not attempt to find. But after crossing and recrossing the gallery two or three times, evidently to be sure it was right, by many efforts with his mandibles, he made a small opening in the gallery and tried to thrust in his head. This caused a commotion inside, and two or three of the soldiers' beaks were seen in the new opening, evidently to learn what was trying to come in from the outside. All seemed to be satisfactory, for the worker was allowed to enlarge the opening, and soon two or three soldiers rushed through and stood guard, until the worker gained admittance and disappeared within. The soldiers followed him, and other workers from the inside finally closed the opening.

The workers and soldiers of the same species from different nests fight, and will not mingle. Young females of the same species from different nests are kindly received, and are at once adopted, according to the observations of Mr. Beaumont. Dr. Hagen is of the opinion that two or three species often live in common in the same nest This is not true upon the Isthmus. One important thing to be observed in securing specimens from the galleries is, that occupants of two different galleries must not be included in the same collection, as if they were of one species. The galleries of two species are often within a few inches of one another on the same post or tree. This was very confusing in the first series of specimens obtained. And it was only after the differences in the galleries were more familiar that the species could be separated. Dr. Hagen has never been in a tropical country, and is obliged to study the species from the specimens sent him. I expect some of his collectors have included specimens from two or more galleries in the same bottle.

Queens.—This class of individuals in a Termite community has always excited the chief interest. Dr. Hagen thinks but one queen will be found in one nest. In nearly all of the queen-cells from the Isthmus and now before you more than one queen was found. These queens are comparatively smaller than those from Africa, which are of other species. Dr. Hagen showed me queens from Africa, ranging from two to six inches in length, the largest being over one inch in diameter near the head. In transverse section they are not round, as are the queens before you, the dorsal view being broad, the median line being slightly depressed, as though formed of two cylinders laid side by side, the spaces between being occupied by the digestive and nervous systems of the queen. This feature will be understood when explaining a section of the queen of *Eutermes*.

The enormous development of the bodies of the African queens, to several thousand times the size of a worker's body, is due to the growth of the ova contained therein. It is reported that the African queens lay an egg every second, or over 80,000 per day, and that they continue this for a year or more. This does not seem possible. It implies that the queen can continuously create nervous energy, without rest. And, further, that

she can digest large quantities of food—two or three times the bulk of the eggs produced.

But one observation has been obtained upon the rate of egg-laying by any of the queens on the Isthmus. Immediately after one of the queen-cells was broken open, the captured queen deposited fifty eggs in a period of ten minutes. She was observed for five minutes longer, but no more eggs were produced. This was under abnormal circumstances, and cannot be taken as a normal rate. There is no question, however, about one queen being able to produce countless numbers of eggs. For her abdomen is but a vast aggregation of egg-tubes, containing

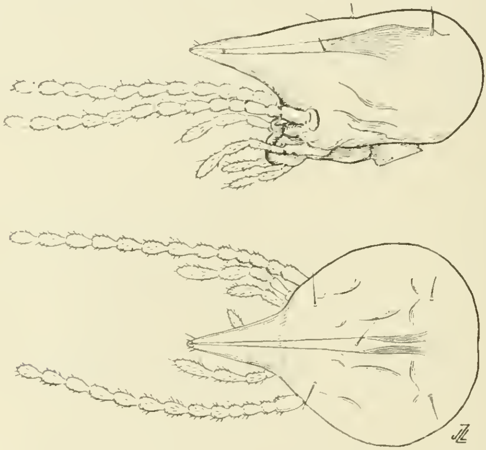


FIG. 8.—Head of *Eutermes* soldier (nasutus), × 25, showing five large tactile hairs upon the cranium; also the tube of "the gun," in the interior of the head, appearing through the chitine. The upper figure is a side view, and the lower figure a top view of the same species.

ova from the merest germs to those nearly developed. The bundles of egg-tubes form two series, one on either side of the median line, until they are united near the posterior portion of the abdomen by a common oviduct, through which the eggs pass to be fertilized before oviposition. At the upper or blind end of the egg-tubes the germs are so small that several are contained in the caliber of the tube ; but, as the germs increase in size, the number becomes less, until three eggs fill the caliber of the tube—then two, and finally one, where they are joined like

a chain. Slide, No. 36 shows a few of the egg-tubes, the nuclei appearing quite distinct. The epithelial cells of each egg are very marked. Few slides can be more interesting, when one understands the progressive development of the eggs.

Slide, No. 37 is interesting as showing the eggs taken from a nest and stained in picro-carmine. Those which have not undergone much development seem to be only stained yellow, while those whose cell-tissue has started are stained carmine.

The ganglion—Slide, No. 38—will be of interest from its large size. I should expect that the queen would have periods

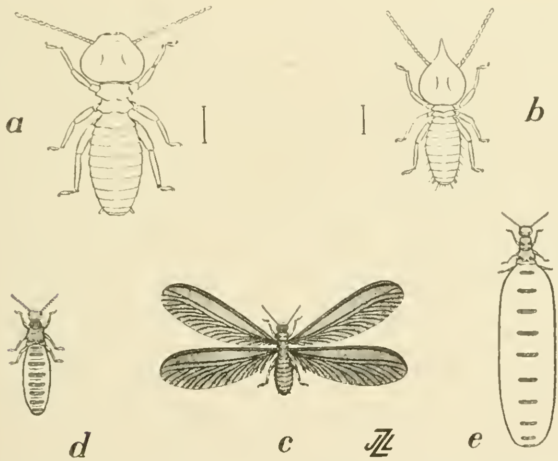


FIG. 9.—*Eutermes* sp. *a*, worker (× 5.); *b*, soldier (× 5.); *c*, queen, before swarming; *d*, queen after impregnation; *e*, queen matured. (*c*, *d*, *e*, natural size.)

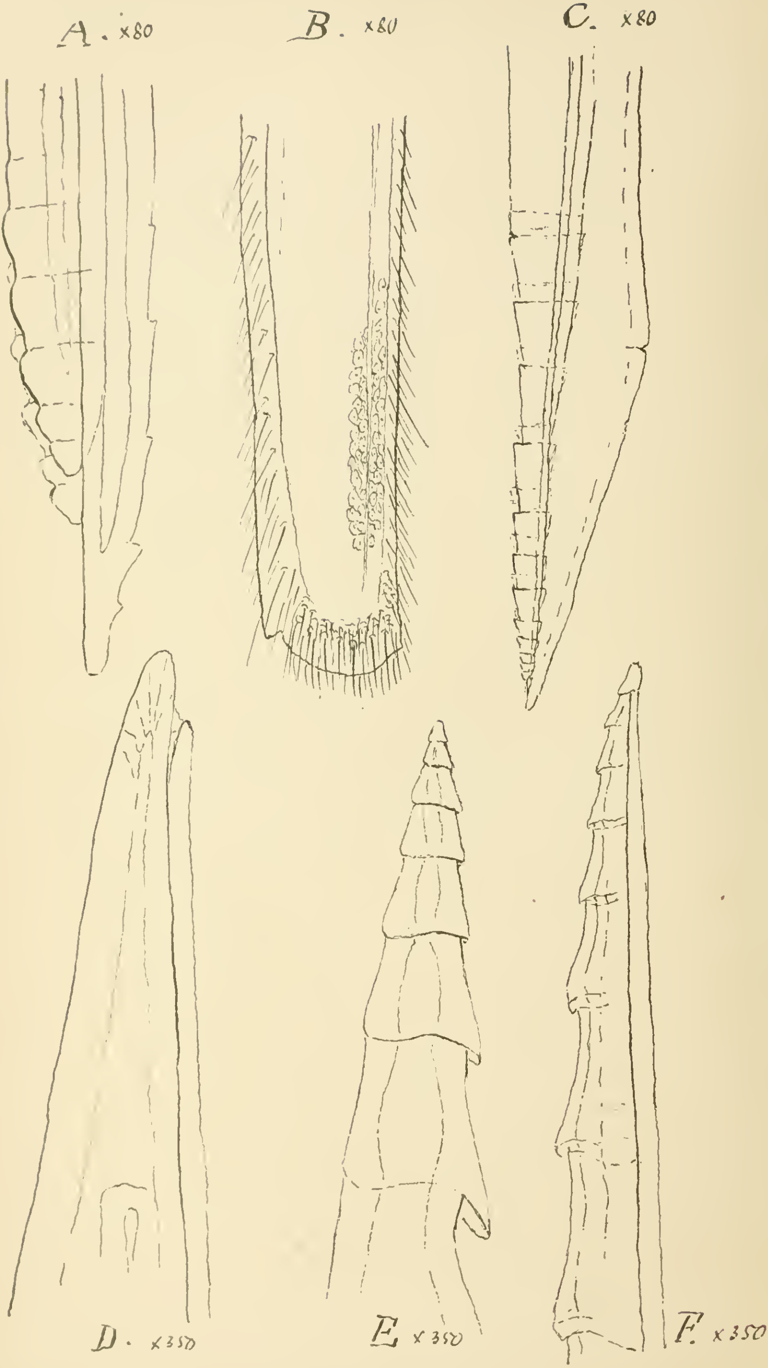
of repose as well as of activity. This is true of the workers. The malpighian vessels are very large and prominent, as would be expected.

The head of a queen—Slide, No. 40—resembles that of a worker, though much larger, and it has eyes.

The destruction of wood-work on the Isthmus, by the combined action of fungi and Termites, cannot be estimated. The loss to the Panama Railway Company, and to the Panama Canal Company is many millions of dollars. Much of the plant of the latter has been rendered useless by these two agencies. When

on the Isthmus I recommended the substitution of more durable woods than the ordinary ones from this section, a dry-house to prepare the lumber for the coaches and cars, and the treatment of some portions of the frame-work of the coaches. These suggestions were carried out at once, resulting in a benefit as far as the application extended. It is quite necessary to treat the wood so that the interior is well protected, or external treatment will be of little avail against fungi and Termites.*

* Since reading the above paper, Dr. Hagen, the Authority on Termites, has identified four species, from the Isthmus. Others of the species are new and unknown.



RIEDERER ON OVIPOSITORS.

PROCEEDINGS.

Meeting of December 21st, 1888.

The President, Mr. Charles F. Cox, in the chair.

Thirty-two persons present.

The Committee on Nomination of Officers for the ensuing year presented its report.

Mr. P. H. Dudley read a Paper, entitled "The Termites, or so-called 'White Ants' of the Isthmus of Panama." This Paper is published in this number of the Journal, p. 56, and was illustrated by many specimens, as follows :—

MICROSCOPICAL SLIDES AND SPECIMENS EXHIBITED.

No. 1. Portion of nest of *Eutermes*.

Nos. 2, 3, 4, 5, 6, 7, 8 and 9. Queen-cells from various nests.

Vials containing Queens—No. 10. Before swarming. No. 11. After. Nos. 12, 13 and 14. As found in the cells.

Vials containing Workers and Soldiers—Nos. 15, 16, 17, 18 and 19. Specimen No. 20. Section of Gallery. Nos. 21, 22, 23 and 24. Wood from Buildings, Cars and Furniture attacked by the Termites.

Objects under the Microscopes.

No. 25. Soldier of *Termes flavipes*, common in the United States.

Nos. 26, 27, 28 and 29. Heads of Soldiers with mandibles, from the Isthmus.

No. 30. Nasutus Soldier of the *Eutermes*.

Nos. 31 and 32. Transverse and longitudinal sections through head of same.

No. 33. *Eutermes* Worker entire.

No. 34. Head of Worker, mandibles open.

No. 35. Section from Worker's body, showing special glands and eductor for cement (?)

No. 36. Portion of the Ovarium of Mature Queen, showing progressive development of the eggs.

No. 37. Eggs from nest.

No. 38. Ganglion of the Ventral Chain, from Queen.

Explanation of Plate 18.

A, Ovipositor proper of *Rhyssa atrata*. ***B,*** sheath of the same. ***C,*** ovipositor proper of *Cryptus samiæ*. ***D,*** dorsal part of the same. ***E*** and ***F,*** ventral parts of the same, in different positions.

No. 39. Malpighian vessels, from Queen.
No. 40. Head of Queen.
No. 41. Vaulting Soldier.
No. 42. Head of Worker.
No. 43 Head of Worker, of same species as No. 35.
No. 44. Head of Worker, of same species as No. 27.
No. 45. Head of Worker found in railway coach.
No. 46. Mandibles of the same.
No. 47. Head of Nasutus Soldier.
No. 48. Mouth of *Eutermes* Worker.
No. 49. Head of young male or female.
No. 50. Longitudinal section of the same.
No. 51. Wing of Queen.

No. 52. Transverse section of undeveloped Queen through abdomen, near thorax.

No. 53. Transverse section near centre of abdomen of the same.

No. 54. Transverse section near posterior portion of abdomen of the same. The last three slides show the position of the egg-tubes.

No. 55. Integument of Queen.

The specimens of Nests and Termites were collected and sent from the Isthmus by Mr. J. Beaumont.

Most of the slides and all the sections were prepared by Mr. L. Riederer.

Mr. J. Beaumont of the Panama Railway Company being present, with other interesting items of information, stated that he had more or less acquaintance with Termites for thirty years. They are so delicate that they cannot endure exposure to topical winds, rains, or heat of the sun. They cannot walk over a hot board, exposed in the sun. Therefore they are very careful to protect themselves by their galleries and passages. In the forest the galleries are always built on the under side of the limbs of trees, to avoid the effects of rains. Queen-cells are found near the centre of a nest. The exterior of a nest is brittle, but the older interior portions are very firm and hard. On disturbing a nest in a tree, almost immediately the entire trunk will be so covered with descending Termites as to appear as if the tree were shedding its bark.

The Panama Canal Company offered for sale two locomotives,

built at Paterson, N. J., and standing for some time protected from the weather in one of the buildings of that Company on the Isthmus. He was sent to examine them. The varnish on the wood-work of the cabs was unscratched. But he noticed galleries of the Termites proceeding from the ground, up the driving wheels, through the machinery to the cabs of the locomotives. On closer inspection he found the cabs so eaten by Termites that he could thrust the blade of a pocket-knife through any portion of the wood. The locomotives were purchased after compensation had been arranged for the construction of new cabs.

Mr. C. Van Brunt said that some years ago, at his home, a plant of Oleander, growing in a tub filled with earth, was brought in the house over night for protection from sudden cold. On the next morning many delicate tubes were found hanging in festoons from the edge of the tub to the floor. These tubes were doubtless the work of our native Termites.

Mr. J. L. Zabriskie said that the main portion of the old house in which he was born at Flatbush, Long Island, was built of brick, imported from Holland; that it endured for over one hundred and fifty years, and was demolished in 1877. During his boyhood he was frequently interested in examining, in certain little used portions of the cellar of the old house, the work of insects, consisting of tubes of varying length hanging in mid-air from the large floor-beams overhead. The tubes appeared to be made from pellets of the softened exterior of the beams. Whitish insects with brown heads could be seen working at the lower open ends of the tubes. He had preserved such a tube, about one foot long and of the diameter of a cedar lead-pencil, for over a dozen years, pinned in an insect case. These tubes were doubtless the work of our native *Termes flavipes*, Kollar.

The thanks of the Society were tendered Mr. Beaumont for his interesting observations and descriptions.

Meeting of January 4th, 1889.

The President, Mr. Charles F. Cox, in the chair.

Forty-one persons present.

Mr. William Lummis was elected a Resident Member of the Society.

The Annual Reports of the Recording Secretary, the Treasurer, the Committee on Publications, the Curator, and the Librarian were presented and adopted.

The President delivered the Annual Address, entitled "The Spontaneous Generation Theory, and its relation to the general theory of Evolution." This Address is published in the January number of the present volume of the JOURNAL, p. 1.

ELECTION OF OFFICERS.

The President announced the closing of the polls, and declared the result of the balloting to be the election of the persons nominated at the last meeting by the Committee on Nomination of Officers for the ensuing year, as follows :—

For President, C. F. COX.
For Vice-President, P. H. DUDLEY.
For Recording Secretary, G. E. ASHBY.
For Corresponding Secretary, J. L. ZABRISKIE.
For Treasurer, C. S. SHULTZ.
For Librarian; L. RIEDERER.
For Curator, W. BEUTTENMÜLLER.
For Auditors, F. W. DEVOE. W. R. MITCHELL, F. W. LEGGETT.

OBJECTS EXHIBITED.

1. Ovipositor of *Rhyssa atrata* : by L. RIEDERER.
2. Ovipositor of *Cryptus samiæ* : by L. RIEDERER.
3. Section of Agate : by J. D. HYATT.
4. *Arachnoidiscus Japonicus* : by E. J. WRIGHT.
5. Section of White Granite : by T. B. BRIGGS.
6. Section of Oolitic Chert, from a boulder in the limestone of Dutchess Co, N. Y.: by J. D. HYATT.

OVIPOSITORS OF RHYSSA ATRATA AND CRYPTUS SAMIÆ.

[See Plate 18, and description, p. 71.]

Mr. Riederer, in explaining his exhibits, said :—"Like the ovipositors of all the *Ichneumonidæ* these consist of the ovipositor proper and two sheaths. The ovipositor proper serves for the boring of bark or wood, or the stinging of larvæ and pupæ, according to the nature of the species, and also for the conducting of the eggs to the place, where they are to be deposited.

The sheaths, especially in species with long ovipositors, serve for directing the ovipositor proper. The sheaths are flat, flexible limbs, somewhat expanded near the end, and more or less thickly covered with hairs, which serve as organs of sense of feeling. The ovipositor proper is laterally compressed, and possesses the elasticity and stiffness of a horse-hair. It is composed of three parts—the middle or dorsal, and two ventral pieces. These are all formed of chitine, and are colored yellow or bronze according to their thickness. The dorsal piece looks like a ribbon folded lengthwise, the fold being dorsal, with the edges each forming another plicature inward. The two ventral pieces are also ribbon-like, folded lengthwise, so that, in transverse section, they resemble the letter S. The ledges and grooves thus formed are so joined, that the ventral parts are securely locked to the dorsal part. But the single pieces can freely slide upon each other for a certain distance.

" The ovipositors of *Cryptus* and *Rhyssa* are quite different. In *Cryptus* the tips are very sharp, like lancets. The ventral pieces, next to the tip, are indented on the outer surface, so that they exhibit very sharp barbs increasing in size up to the ninth barb. The four barbs beyond these decrease in size to mere marks. The pieces are very slender, increasing in diameter up to the thirteenth barb. Here they bear two bristles pointing downwards towards the tip and inwards towards the ventral piece. From this place up they grow a little thinner. The dorsal piece is nearly without indentation, and increases in size gradually up to the ninth barb of the ventral piece, as seen when all the tips are together. At this place there is a slight recess, and the thickness decreases rapidly about one-third. In this position the greatest diameter of the whole ovipositor proper is between the ninth barb of the ventral pieces and the recess on the dorsal piece ; but, by pulling the ventral pieces backwards, this thickest part can be reduced to the diameter of the remaining ovipositor.

" *Rhyssa* has on the dorsal piece five comparatively small projections. The nine projections on the ventral pieces have no sharp edges, but are rounded off. Through the substance of the single pieces of every ovipositor are seen to pass tracheæ and bundles, probably, of muscles.

" The boring action of the ovipositor can be understood, if we consider that the barbs of the ventral pieces take hold on the

wall of the hole, punched before by a thrust of the stronger dorsal piece, as soon as it is inserted there, after having somewhat retracted the ventral parts. This preventing a backward motion, the resistance is given, necessary to push forward another piece in alternation. At the same time the bored hole is filed out to the size of the thickest part of the ovipositor As this part can be made thinner by displacing the constituent pieces, the whole tool can be removed again out of the drilled hole. An egg, between the two ventral pieces, will force them from each other, and consequently be retained by them under a slight springy pressure. By the reciprocal movement of the two ventral pieces the egg will be forced downwards."

Meeting of January 18th, 1889.

The President, Mr. Charles F. Cox, in the chair.

Forty-two persons present.

The following Committees were appointed by the Chair :—

Committee on Admissions : F. W. Devoe, W. R. Mitchell, W. E. Damon, G. F. Kunz and W. Wales.

Committee on Publications : J. L. Zabriskie, William G. De Witt, E. B. Grove, Walter H. Mead and John L. Wall.

Prof. Samuel Lockwood, Ph. D., addressed the Society on "The Comparative Hygiene of the Atmosphere in relation to Hay-Fever." This Address is published in this number of the Journal, p. 49.

Prof. Alexis A. Julien, Ph. D., read a Paper, entitled "Notes on a New Ochraceous Thallophyte." This Paper was illustrated by microscopical mounts and black-board sketches, and is published in the January number of the present volume of the Journal, p. 31.

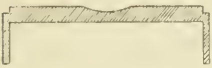
OBJECTS EXHIBITED.

1. A new Ochraceous Thallophyte : by A. A. Julien.
2. Minute fossil shells, from Ireland : by K. M. Cunningham (a visitor).
3. Diatoms of the Atlantic Coast : by K. M. Cunningham.
4. Mycelium of a fungus from the floor of a wine-cellar at Newburgh, N. Y.: by Miss H. S. Wingate (a visitor).
5. A nest of Watch-glass Covers : by J. L. Zabriskie.

Of his exhibit Mr. Zabriskie said :—

"This is an inexpensive, compact, convenient and effectual contrivance for keeping a number of specimens, during maceration in watch-glasses, free from dust and too rapid evaporation.

"Each cover is composed of a disk of wood, $2\frac{1}{8}$ inches in diameter and $\frac{19}{32}$ds of an inch thick. A cavity is turned in the under side of the disk, 2 inches in diameter and $\frac{7}{16}$ths of an inch deep, this cavity being of sufficient size to easily contain an ordinary deep watch-glass. A shallow depression, $\frac{1}{2}$ of an inch



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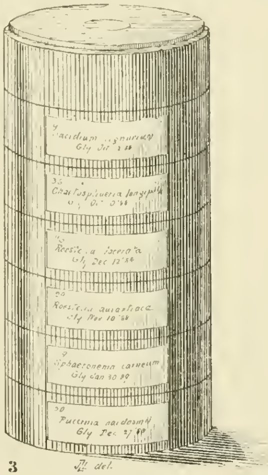

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A NEST OF WATCH-GLASS COVERS.

FIG. 1.—A central, vertical section of a cover.
FIG. 2.—A cover with its label and watch-glass in position.
FIG. 3.—A nest of seven covers enclosing six watch glasses.

in diameter, is turned in the centre of the upper surface. When a watch-glass is seated in this depression, the latter tends to keep the glass in position without much risk of rolling or moving. A square shoulder, $\frac{1}{16}$th of an inch deep is also turned around the circumference of the upper surface, which shoulder loosely retains the lower edge of the next superimposed cover, tending to prevent the displacement of the latter. The covers are all made of the same size and form, so that they are interchangable.

"A label, containing the name of the specimen and any desired additional note, is pasted on the circumference of each disk. This label refers to the specimen in the glass seated upon the upper surface of each respective disk.

"The first cover, with its appropriate label, is used to support the first watch-glass with its macerating specimen. The second cover, with its label and watch-glass, is placed in position upon the shoulder of the first cover, and the operation is repeated until six disks supporting six watch-glasses, capped by a seventh disk, used literally as a cover, rise in a column about 4¼ inches in height. This column, or nest of covers is not easily overturned or jarred out of position.

"If several such nests of specimens are placed in a shallow open box, like a cigar-box with the lid removed, they can be easily moved all together without much risk of upsetting, and any one specimen can be easily distinguished by its label, and instantly secured for manipulation.

"Such wooden covers retard, but do not prevent evaporation. At the ordinary temperature of a living room, sixty drops of water in one watch-glass will be retained from forty-eight to sixty hours. For maceration in a mixture of glycerine, water and alcohol, where the gradual evaporation of the water and alcohol is desirable, they answer admirably. The specimens can be kept in the concentrated glycerine indefinitely.

"Suitable deep watch-glasses may be purchased of Albert Berger & Co., 47 Maiden Lane, New York City, for one cent each. The covers can be turned for about three cents each.

"At the suggestion of Dr. A. A. Julien, such covers were treated by immersion in hot paraffin, and their retaining power was found to be greatly increased. Sixty drops of water could be retained in any of the respective glasses for about seven days. Such paraffined covers can be made for about five cents each."

Meeting of February 1st, 1889.

The President, Mr. Charles F. Cox, in the chair.

Thirty-three persons present.

Mr. James Godwin was elected a Resident Member of the Society.

Mr. William G. De Witt, the Treasurer of the Committee on Publications, reported upon the finances of the Journal, and the report was referred to the Auditors.

Mr. Walter H. Mead announced the death of the late Corresponding Secretary, Mr. Benjamin Braman, which occurred at

Norton, Mass., on January 20th, 1889, and he reviewed Mr. Braman's connection with the Society, and his literary and scientific work.

On motion, the following Committee, to formulate suitable action of the Society upon the death of Mr. Braman, was appointed by the Chair :—Walter H Mead, William E. Damon and John L. Wall.

Dr. H. Hensoldt addressed the Society on "Echinoderms, and what they teach us." This Address was illustrated by black-board sketches and table-specimens.

OBJECTS EXHIBITED.

1. An original letter of Charles Darwin to Prof. Owen, written in March, 1848, and almost wholly relating to the microscope : by Chas. F. Cox.

2. Beef-fat crystals, polarized : by E. J. Wright.

3. Diatoms, from Salt Lake Desert : by K. M. Cunningham (a visitor).

4. Foraminifera, from Kansas chalk : by K. M. Cunningham.

5. Foraminifera, from N. J. greensand : by K. M. Cunningham.

6. Vegetable tissues, from clay of New York City : by K. M. Cunningham.

7. A fungus destructive to fish in aquaria : by F. W. Leggett.

Apropos of his exhibit, Mr. Cox spoke of the quantity and quality of Charles Darwin's microscopical work, and read extracts from his Life and Letters in illustration of the progress made by him in the knowledge and the manipulation of the microscope and its accessories, from the time when, before the Beagle voyage, in 1831, Robert Brown, the botanist, allowed him a glance at 'his little secret' (probably cyclosis in a plant-cell), down to the period in his later life when he was engaged in constant microscopical investigation, in connection with his study of insectivorous plants, in which he found need for the higher powers of the best compound instrument.

Mr. Cox spoke also of the interest attaching to the fact that Mr. Darwin actually devised and carried into effect manifest improvements in the simple dissecting microscope, as shown by the letter, which he then read and passed to the members.

The letter is as follows ;—the date being supplied from the post-marks which it bears.

"DOWN, FARNBOROUGH, KENT.
Sunday [March 26, 1848].

"*My Dear Owen*,

I do not know whether your MS. instructions are sent in : but even if they are not sent in, I dare say what I am going to write will be absolutely superfluous, but I have derived such infinitely great advantage from my new simple microscope, in comparison with the one, which I used on board the Beagle and which was recommended to me by R. Brown, that I cannot forego the mere *chance* of advantage of urging this on you. The leading point of difference consists simply in having the stage for saucers very large and fixed. Mine will hold a saucer 3 inches in inside diameter. I have never seen such a microscope as mine, though Chevalier's (from whose plan many points of mine are taken) of Paris approaches it pretty closely. I fully appreciate the utter ABSURDITY of my giving you advice about means of dissecting ; but I have appreciated myself the enormous disadvantage of having worked with a bad instrument, though thought a few years since the best. Please to observe that without you call especial attention to this point, those ignorant of natural history will be sure to get one of the fiddling instruments sold in shops. If you thought fit I would point out the differences which, from my experience, make a useful microscope for the kind of dissection, of the invertebrates, which a person would be likely to attempt on board a vessel. But pray again believe that I feel the absurdity of this letter, and I write merely from the chance of yourself possessing great skill and having worked with good instruments, may not possibly be fully aware what an astonishing difference the kind of microscope makes for those who have not been trained in skill for dissection under water.

"When next I come to town (I was prevented last time by illness) I must call on you, and report *for my own satisfaction*, a really (I think), curious point I have made out in my beloved Barnacles. You cannot tell how much I enjoyed my talk with you here. Ever, my dear Owen,

Yours sincerely,

C. DARWIN.

(Over.)

"P. S.—If I do *not* hear, I shall understand that my letter is superfluous. Smith and Beck were so pleased with the simple microscope they made for me, that they have made another as a model: if you are consulted by any young naturalists, do recommend them to look at this: I really feel quite a personal gratitude to this form of microscope and quite a hatred to my old one.

[Addressed]

"PROFESSOR OWEN
Royal College of Surgeons
Lincoln Inn Fields
London."

Mr. Cunningham donated the four slides of his exhibit to the Cabinet of the Society.

On motion, the thanks of the Society were tendered Mr. Cunningham for this donation.

MEETING OF FEBRUARY 15TH, 1889.

The Vice-President, Mr. P. H. Dudley, in the chair.

Twenty-four persons present.

The Corresponding Secretary, J. L. Zabriskie, announced the death of a Resident Member of the Society, S. Lowell Elliott, Ph. D., which death occurred at his residence, Brooklyn, N.Y., on the 12th inst.

The Committee on the Annual Reception reported progress.

OBJECTS EXHIBITED.

1. Water from "Great Salt Lake," Utah: by P. H. DUDLEY.
2. Sand from "Great Salt Lake," Utah: by P. H. DUDLEY.
3. Photomicrograph of the *Artenna Fertilis*, or Brine Shrimp, the only living creature said to be found in the "Great Salt Lake," Utah: by P. H. DUDLEY.
4. Wings of *Termes testaceous*, from Panama: by P. H. DUDLEY.
5. Wings of *Eutermes*, from Panama: by P. H. DUDLEY.
6. Section of Wood, eaten thin by Termites, from Panama: by P. H. DUDLEY.
7. Tarsus of *Calotermes marginipennis* (?) from Panama: by P. H. DUDLEY.

8. Section of Crocidolite, from Orange River, South Africa: by J. D. HYATT.

9. Transverse section of Jasperized Wood, from Arizona: by J. D. HYATT.

10. Ovarian tubes of Termite: by L. RIEDERER.

Mr. Dudley read a letter from Mr. J. Beaumont of the Isthmus of Panama, relating his further studies of the Termites.

Objects 1, 2 and 3 from Great Salt Lake, exhibited by Mr. Dudley, were furnished by Mrs. L. E. Holden of Salt Lake City.

PUBLICATIONS RECEIVED.

The American Monthly Microscopical Journal: Vol. X., Nos. 1, 2 (January, February, 1889).

The Microscope: Vol. IX, Nos. 1–3 (January–March, 1889).

The Microscopical Bulletin and Science News: Vol. V., No. 6 (December, 1888).

Anthony's Photographic Bulletin: Vol. XX., Nos. 1–5 (January 12–March 9, 1889).

Bulletin of the Torrey Botanical Club: Vol. XVI., Nos. 1–3 (January–March, 1889).

The Botanical Gazette: Vol. XIV., Nos. 1, 2 (January, February. 1889).

The Journal of Mycology: Vol. IV., No. 12 (December, 1888).

The West American Scientist: Vol. V., No. 3 (November, 1888).

The School of Mines Quarterly: Vol. X., No. 2 (January, 1889).

Entomologica Americana: Vol. V., Nos. 1, 2 (February, March, 1889).

Proceedings of the Natural Science Association of Staten Island: Meetings of January, 12 and February 9, 1889.

The Brooklyn Medical Journal: Vol. III., Nos. 1–3 (January–March, 1889).

Indiana Medical Journal: Vol. VII., Nos. 7–9 (January–March, 1889).

The Swiss Cross: Vol. V., Nos. 2, 3 (February, March, 1889).

The Hahnemannian Monthly: Vol. XXIV., Nos. 2, 3 (February, March, 1889).

Psyche: Vol. V., Nos. 153–155 (January–March, 1889).

The Pacific Record of Medicine and Surgery: Vol. III., Nos. 6, 7 (January, February, 1889).

The American Lancet: Vol. XIII., Nos. 1, 2 (January, February, 1889).

The Electrical Engineer: Vol. VIII., Nos. 86, 87 (February, March, 1889).

Mining and Scientific Review: Vol. XXII., Nos. 1–10 (January 3–March 7, 1889).

The Rocky Mountain Druggist: Vol. II., Nos. 1, 2 (January, February. 1889).

National Druggist : Vol. XIV., Nos. 2–5 (February 1–March 1, 1889).

The Variation of Decomposition in Iron Pyrites: Parts I. and II. By Alexis A. Julien, Ph. D. From the author.

The Decay of the Building Stones of New York City. By Alexis A. Julien, Ph. D. From the author.

Bulletin of the New York State Museum of Natural History : Nos. 4–6 (August–November, 1888).

Forty-first Annual Report of the New York State Museum of Natural History (1887).

Fourth Annual Report of the New York State Entomologist (1887).

Journal of the Elisha Mitchell Scientific Society: Vol. V., Part 2 (July–December, 1888).

Annual Report Museum of Comparative Zoölogy, Cambridge, Mass.: (1887–88).

Journal of the Cincinnati Society of Natural History : Vol. XI., No. 4 (January, 1889).

Ninth Annual Report of the New York Free Circulating Library (1888).

Extracts, Microscopical Department of the American Naturalist : By Dr. C. O. Whitman. From the author.

Food versus Bacilli in Consumption : By Dr. Ephriam Cutter. From the author.

Agricultural Experiment Station of Alabama : Bulletins Nos. 1–3 (July, 1888–January, 1889).

Cornell University College of Agriculture : Bulletins Nos. 3, 4 (November, December, 1888).

Bulletin of the Essex Institute: Salem, Mass. Vol. XX., Nos. 1–3 (January–March, 1888).

Journal of the Royal Microscopical Society : 1888, Part 6 a, 1889, Part 1.

The Naturalist : Nos. 162-164 (January–March, 1889).

Journal of the Quekett Microscopical Club : Vol. III., No. 23 (January 1889)

Journal of Microscopy and Natural Science : Vol. II., Part 5 (January, 1889).

Proceedings and Transactions of the Natural History Society of Glasgow : Vol. II., Part 1 (1886–87).

Transactions of the Nottingham Naturalists' Society : (1888).

The Canadian Record of Science : Vol. III., No. 5 (January, 1889).

The Ottawa Naturalist: Vol. II., No. 7 (November, 1888).

Journal and Proceedings of the Royal Society of New South Wales : Vol. XXII., Part 1 (1888).

The Victorian Naturalist : Vol. V., Nos. 7–9 (November, 1888–January, 1889).

Société Royale de Botanique de Belgique : Comptes-Rendus (January, February, 1889).

Wissenschaftlichen Club in Wien : Monatsblätter, Vol. X., Nos. 3, 4 (December, 1888, January, 1889); Ausserordentliche Beilage, Vol. X., No. 1 (1889).

Verhandlungen und Mittheilungen des Siebenbürgischen Vereins für Naturwissenschaften in Hermannstadt: Vol. XXXVIII (1888).

Naturwissenschaftlichen Verein des Reg.-Bez., Frankfurt a. O.: Monatliche Mittheilungen, Vol. VI., Nos. 7–9 (October–December, 1888).; Societatum Litteræ, Vol. II., No. 9 (September, 1888).

Jahrbücher des Nassauischen Vereins für Naturkunde, Wiesbaden: Vol. XLI (1888).

Società Italiana di Microscopisti, Acireale, Sicily: Ricerche (1888).

Nuovo Giornale Botanico Italiano, Firenze: Vol. XXI., No. 1 (January, 1889).

Bollettino della Società Africana d'Italia, Napoli: Vol. VII., Nos. 11, 12 (November, December, 1888).

Memorias de la Sociedad Cientifica "Antonio Alzate," Mexico: Vol. II., No. 5 (November, 1888).

BENJAMIN BRAMAN.

JOURNAL

OF THE

NEW-YORK MICROSCOPICAL SOCIETY.

VOL. V. JULY, 1889. No. 3.

BENJAMIN BRAMAN.

Benjamin Braman died on the 20th day of January, 1889. The illness which resulted in his death had lasted over a year, and had confined him in bed the greater part of that time. The wonderful amount of will-power possessed by him, and which had enabled him during many years of ill health to pursue his professional labors, undoubtedly added months to his life after his fatal illness was upon him. He was born in Norton, Massachusetts, on the 23d day of November, 1831, and was lineally descended from one of the original founders of Plymouth colony. He received his early education in his native town, and graduated from Brown University in 1854. Subsequently he entered the Theological Seminary at Andover, and graduated therefrom in 1859, thus fitting himself for the vocation he had long intended to follow, namely, that of a minister of the Christian religion. Indeed, so powerfully was he urged by a sense of duty and responsibility to enter the ministry, that about this time he refused very lucrative and promising offices in lay institutions of learning. When, soon after he left Andover, he commenced, at Shutesbury, to exercise his calling from the pulpit, he found to his sorrow that a bronchial weakness to which he was subject, so much interfered with his utterance that he was compelled to cease temporarily, and finally, permanently, his efforts to preach. Nor could he at any time afterward make such use of his voice as would be absolutely necessary for him properly to discharge his duties as a clergyman. He therefore withdrew entirely from that profession, and became the principal of a high-school in Westport. For a few months this occupation seemed suited to him. After that time, however, it was evident that the unremitting attention which he bestowed upon his labors, and which his

conscientiousness made imperative with him—one of his characteristics being the thoroughness with which he treated every task set before him—was too heavy a draft upon his delicate organization. "I have not," he said, in 1887, "I have not been free from pains in the head for twenty-five years." He gave up the school. He came to New York. No steady professional employment seemed suited to his peculiar condition of physical health. Therefore, to exercise his abilities and to put to profitable use in such manner as his health permitted, the learning with which his mind was stored, he adopted the plan of giving instruction by lessons of short duration in the more recondite lines of study, to the high grades of private schools, to individuals and to such institutions as the Cooper Union of New York. By this means he obtained intervals of rest between his mental labors and thus was enabled to follow the plan for a number of years, to the very great advantage of those who were privileged to receive his instruction. Except for his imperfect health he would have entered the faculty of some college, chairs in several of which were within his acceptance, or he would have taken the position offered to him by the government of one of the thriving South American states—a position for which his qualifications adapted him—namely, that of director and superintendent of the entire educational affairs of that country. Thus hampered by circumstances over which he had no control, subject constantly to ill-health which defied all remedial skill, and which rendered impossible the free exercise by him of his mental powers, Benjamin Braman had no opportunity of obtaining that high place in the world of letters which his intellect untrammeled would assuredly have won for him. No evidence of disappointed hopes ever appeared, however, in his words or in his looks: his sympathetic nature remained unchanged, his ardor as a teacher suffered no abatement, his suavity of manner underwent no alteration. During his residence in New York he was an active member of the Young Men's Christian Association, and always manifested much interest in its concerns. For four successive years, commencing in 1865, he was President of the Literary Society of that Association. In 1879 he became a member of the New-York Microscopical Society, served as its President during 1883 and 1884, and edited its Journal for the years 1884 and 1885. His mind was

singularly gifted. It enabled him to treat in his lectures subjects so diverse as Mental Philosophy and the Science of Perspective, Ancient Literature and Botanical Physiology; and although no original work can be included in a record of his performances, he was instrumental in disseminating much thorough and valuable knowledge through the medium of his lectures. For those who attended them his brilliant understanding illuminated all that was dark before in the most abstruse problems of the studies which they pursued And the winning manner of the teacher transformed his pupils into his friends—friends who followed his future endeavors with solicitude, who lingered affectionately around him in his hours of illness, and who solaced his last days by every office the kindliest feeling could devise. Mr. Braman was married to Martha W. Bowers, of Providence, in 1862. Within two years thereafter, she died. He suffered intensely from the effects of her death, nor did he during his life ever cease to cherish her memory with mournful fidelity. The shock and the loss he sustained in her death influenced, to its detriment probably, his whole subsequent career. His life, pure and unselfish in its every act and relation, childlike in its reverence for matters of faith and religion, though passed outside of the glare of public observation, presented an example which was as effective in the promotion of good among his fellows as were his intellectual labors successful in imparting knowledge; and the picture of his beautiful character will fade in the memory of those who came within its influence when the stars fade on their vision and not till then.

PROCEEDINGS.

Meeting of March 1st, 1889.

The President, Mr. Charles F. Cox, in the chair.

Thirty-six persons present.

On motion, the Committee on Publications was authorized to publish a new list of the Members of the Society.

The Librarian announced the donation to the Library, by Mr. William G. De Witt, of two bound volumes of the Journal of the Society.

OBJECTS EXHIBITED.

Sections of Agatized Wood, *Dadoxylon* (?) from Chalcedony Park, Arizona.

1. Transverse section, showing concentric growth.
2. Transverse oblique section, showing cell-markings.
3. Transverse section, mostly silicified, obscuring structure.
4. Radial section, showing structure of medullary rays, resin-cells, and double rows of discoid markings of wood-cells.
5. Radial section, showing fungi in cells.
6. Tangential section, showing discoid markings and ends of medullary rays.
7. Tangential section.

These objects—Nos. 1 to 7, inclusive—were prepared and exhibited by Thomas B. Briggs, and their structure was explained by P. H. Dudley.

8. Two mounts of Diatoms, prepared by Toomb: by E. A. Schultze.
9. The new Microscopical Lamp of Kochs and Wolz, Bonn: by Ludwig Riederer.

Meeting of March 15th, 1889.

THE ELEVENTH ANNUAL RECEPTION.

Held in the Rooms of the Society. Living objects only exhibited.

OBJECTS EXHIBITED.

1. Desmids: by Edgar J. Wright.
2. Diatoms: by James Walker.
3. Vorticellæ: by George E. Ashby.
4. Hydra: by E. A Schultze.
5. Daphnia, or Water-Flea: by William G. De Witt.
6. Cilia of Mussel: by J. D. Hyatt.
7. Cyclosis: in Vallisneria: by William Wales.
8. in Nitella Flexilis: by William Beutten-müller.
9. in Anacharis: by Ludwig Riederer.
10. in Hairs of Tradescantia: by Charles F. Cox.

11. EGGS OF SNAIL: by THOMAS B. BRIGGS.
12. CYCLOPS: by F. W. LEGGETT.
13. AMŒBA: by THE SOCIETY.
14. BACTERIA: by THE SOCIETY.
15. ROTIFER: by GEORGE F. KUNZ.
16. CORYNE MIRABILIS: by WILLIAM E. DAMON.
17. CIRCULATION OF BLOOD: in FROG: by JOHN L. WALL.
18. in TADPOLE: by M. M. LE BRUN.
19. in GOLD FISH: by THE SOCIETY.

MEETING OF APRIL 5TH, 1889.

The President, Mr. Charles F. Cox, in the chair.

Twenty-one persons present.

Mr. George S. Davis, and the Rev. George E. F. Hass were elected Resident Members of the Society.

The President addressed the Society on "Reproduction by fission amongst the Ciliata," and illustrated his remarks by black-board sketches and living objects.

OBJECTS EXHIBITED.

1. *Stephanoceros*, under binocular microscope, and with paraboloid illumination: by CHARLES F. COX.

2. *Daphnia pulex*: by WILLIAM G. DE WITT.

3. *Actinospærinum Eichornii*: by WILLIAM G. DE WITT.

4. Applanatic Eye-pieces, made of the "new glass" by Powell and Leland: by WILLIAM G. DE WITT.

5. False gills of pupa of *Agrion*: by L. RIEDERER.

6. Bacteria, suddenly appearing in a glycerine mount, which mount was prepared one year ago: by F. W. LEGGETT.

7. Diatoms, 282 forms, from the Bay of Naples: by E. A. SCHULTZE.

8. Diatoms, Type-slide of *Baltjickii varua*: by E. A SCHULTZE.

9. Diatoms, *Campylodiscus hibernicus*: by E. A. SCHULTZE.

Mr. Schultze remarked concerning his exhibit, No. 7, that it contained a fine collection of 18 forms of *Surirella*, and 3 of

Baltjickii, not quite identical, but evidently varieties of the same genus. Also that on the same slide was a curious form of *Navicula forcipata*, with the unstriated lyrate space not extending to the nodules. And further, on the exhibit No. 10, that Schmidt says—Atlas, Plate 55—"*C. hibernicus*, Ehr. = *C. costatus*;" and, according to Greenow, *C. noricus* may be distinguished from *C. hibernicus* by the costæ of the former being closer than those of the latter.

Mr. Schultze donated slides Nos. 9 and 10 to the Cabinet of the Society.

On motion, the thanks of the Society were tendered the GROLIER CLUB for an invitation to inspect the Japanese paintings, publications and manuscripts on exhibition at the time in the rooms of the Club.

Meeting of April 19th, 1889.

The Vice-President, Mr. P. H. Dudley, in the chair.

Fourteen persons present.

H. Hensoldt, Ph. D. and the Rev. Albert Mann were elected Resident Members; and Alfred C. Stokes, M. D., and Messrs. K. M. Cunningham and C. Henry Kain were elected Corresponding Members of the Society.

OBJECTS EXHIBITED.

1. Spores of the fungus, *Gymnosporangium fuscum*, DC., from trunk of the Red Cedar, *Juniperus Virginiana*, L.: by J. L. Zabriskie.

2. Larva of Mosquito: by L. Riederer.

3. Pupal integument and imago of Mosquito: by L. Riederer.

4. Transverse section of spiracle and trachea of an Ant, *Formica Pennsylvanica*: by L. Riederer.

5. Section of Limestone, from the material of the new building of the *New York Times*: by James Walker.

6. Section of wood of *Pinus palustris*, Miller, Georgia Pine, showing the spiral growth filling up the space, which would otherwise be left between the tracheids on the upper side of a

decayed limb in the substance of a growing tree: by P. H. DUDLEY.

7. An old edition of CHAMBERS ENCYCLOPEDIA—Dublin, 1727: by F. W. LEGGETT.

Mr. Leggett remarked upon the article "Microscope" in the old edition of Chambers Encyclopedia, referring to the manufacture of lenses by forming spherules of glass filaments, heated in an alcohol flame.

Mr. A. Woodward said of exhibit No. 5, that the material was a carboniferous limestone from Ellettsville or Spurgeon Hill, Indiana, and that only one species of *Foraminifera* is found in that material—*Endothyra Baileyi*, Hall sp., mingled with crinoid stems and fragments of *Bryozoa*.

PUBLICATIONS RECEIVED.

The Microscope: Vol. IX., Nos. 4, 5 (April, May, 1889).

The American Monthly Microscopical Journal: Vol. X., Nos. 3–5 (March–May, 1889).

The Natural Science Association of Staten Island: Proceedings, March 14, April 11, May 9, 1889.

The San Francisco Microscopical Society: Proceedings, March 27, April 10, May 8, 1889.

The Torrey Botanical Club: Bulletin, Vol. XVI., Nos. 4, 5 (April, May, 1889).

The Journal of Mycology: Vol. V., No. 1 (March, 1889).

Anthony's Photographic Bulletin: Vol. XX., Nos. 6–11 (March 23–June 8, 1889).

The New York Academy of Sciences: Transactions, Vol. VIII., Nos. 1–4 October, 1888–January, 1889).

The School of Mines Quarterly: Vol. X., No. 3 (April, 1889).

The Academy of Natural Sciences of Philadelphia: Proceedings, Part 3, 1888.

The Davenport Academy of Natural Sciences: Proceedings, Vol. V., Part 1 (1884–1889).

The American Museum of Natural History: Bulletin, Vol. II., No. 2 (March, 1889); Annual Report (1889).

The Essex Institute: Bulletin, Vol. XX., Nos. 4–6 (April–June, 1888).

Methods of Modern Petrography. From the author, H. Hensoldt, Ph. D. Reprint from School of Mines Quarterly, Vol. X., No. 3 (April, 1889).

The West American Scientist: Vol. VI., Nos. 42, 43 (April, May, 1889).

Massachusetts Horticultural Society: Transactions, Part 1, 1888; Schedule of Prizes (1889).

Psyche: Vol. V., No. 156 (April, 1889).

Entomologica Americana: Vol. V., No. 4 (April, 1889).

Insect Life: Vol. I., Nos. 2–11 (August, 1888–May, 1889).

Johns Hopkins University Circulars: Vol. VIII., No. 72 (April, 1889).

The Swiss Cross: Vol. V., Nos. 4–6 (April–June, 1889).

The New York State Fish Commission: Annual Reports (1887, 1888).

Michigan Board of Agriculture: Annual Report (1888).

Agricultural College of Michigan: Bulletins, Nos. 43–48

Washburn College Laboratory of Natural History: Bulletin, Vol. II., No. 9 (February, 1889).

Agricultural Experiment Station, Auburn, Alabama: Bulletin No. 5 (April, 1889).

The Brooklyn Medical Journal: Vol. III., Nos. 4–6 (April–June, 1889).

The Hahnemannian Monthly: Vol. XXIV., Nos. 4–6 (April–June, 1889).

The Indiana Medical Journal: Vol. VII., Nos. 10, 11 (April, May, 1889).

The American Lancet: Vol. XIII., Nos. 3–6 (March–June, 1889).

The Pacific Record of Medicine and Surgery: Vol. III., Nos. 8–10 (March–May, 1889).

The National Druggist: Vol. XIV., Nos. 6–11 (March 15–June 1, 1889).

The Rocky Mountain Druggist: Vol. II., Nos. 3, 4 (1889).

The Electrical Engineer: Vol. VIII., Nos. 88, 89 (April, May, 1889).

Mining and Scientific Review: Vol. XXII., Nos. 11–23 (March 14–June 6, 1889).

Journal of the Royal Microscopical Society: 1889, Part 2.

The Journal of Microscopy and Natural Science: Vol. II., Part 6 (April, 1889).

The Journal of the Quekett Microscopical Club: Vol. III., No. 24 (April, 1889).

Grevillea: No. 83 (March, 1889).

The Naturalist: Nos. 165, 166 (April, May, 1889).

The Canadian Institute: Proceedings, Vol. XXIV., No. 151 (April, 1889).

The Canadian Record of Science: Vol. III., No. 6 (April, 1889).

The Horticultural and Scientific Society of Manitoba: Annual Report (1888); Transactions, Nos. 30–33 (April 26, 1888–January 17, 1889).

The Ottawa Naturalist: Vol. II., Nos. 10–12 (January–March, 1889).

The Victorian Naturalist: Vol. V., Nos. 10–12 (February–April, 1889).

Bolletino della Società Africana d'Italia: Vol. VIII., Nos. 1–4 (January–April, 1889).

Bulletin de la Société d'Etudes Scientifiques d'Angers: Vol. XVII. (1887).

Nuovo Giornale Botanico Italiano: Vol. XXI., No. 2 (April 15, 1889).

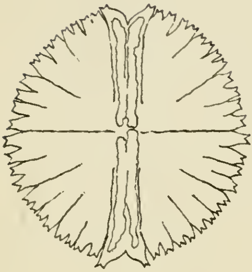
Naturwissenschaftlichen Verein zu Osnabrück: Report (1885–1888).

Wissenschaftlichen Club in Wien: Monatsblätter, Vol. X., Nos. 5–8 (February–May, 1889); Ausserordentliche Beilage, Vol. X., Nos. 2–4 (1889); Report (1888, 1889).

Société Royale de Botanique de Belgique: Comptes-Rendus (March 9–May 5, 1889).

Société Impériale des Naturalistes de Moscou: Bulletin, 1888, No. 3; Meteorologische Beobachtungen (1888).

Académie D'Hippone: Comptes-Rendus, August 13–October 25, 1888.



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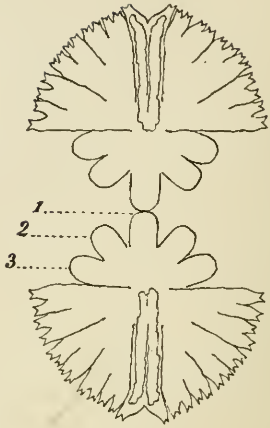

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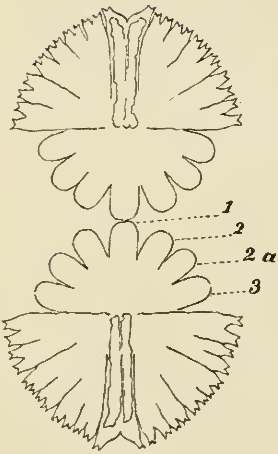

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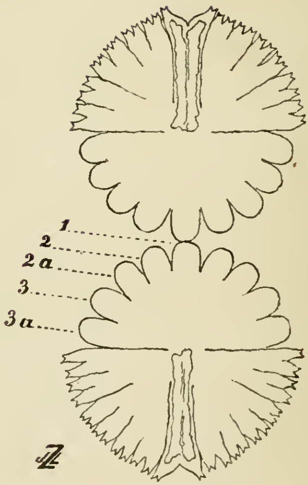

5

HELM ON MICRASTERIAS.

JOURNAL

OF THE

NEW-YORK MICROSCOPICAL SOCIETY.

Vol. V. OCTOBER, 1889. No. 4.

NOTE ON THE BINARY SUB-DIVISION OF MICRASTERIAS DENTICULATA (BREB.), RALFS.

BY STEPHEN HELM.

(*Read October 4th*, 1889.)

On Saturday the 15th of June at 10.45 P. M., I had the good fortune to perceive a solitary specimen of *Micrasterias denticulata* in a state of binary sub-division.

It had then arrived at what I will call the five-lobe stage, *i. e.* the lobe on each side of the connecting central one had already divided, making five, which were as nearly as possible equal in size.

The lobe numbered 2 (Fig. 2) soon gave signs of lateral enlargement, and about 10.55 each top had a small but distinct heart-like depression (Fig. 3).

As the lobe became broader, this depression deepened until 11.30, when the division was completed, and well defined (2, 2*a*, Fig. 4). About 11.25 lobe number 3 (Figs. 2 and 4) on each side evinced signs of enlargement; and at 11.35 the before-mentioned heart-like depression was apparent.

I had, by this time become deeply interested in this simultaneous quadruple growth, when to my intense disgust, and disappointment, down came a *Cypris* and gobbled up my Desmid and brought my observations to a summary conclusion.

I should not have deemed these observations worthy of record, but for the fact of their leading me to a conclusion

Explanation of Plate 20.

Binary sub-division of *Micrasterias denticulata.*

Fig. 1.—Completed Desmid; the new, upper half not yet equal in size to the old lower half. **Fig. 2.**—The "five-lobe stage." **Fig. 3.**—"Heart-like depression" of a lobe. **Fig. 4.**—The "seven-lobe stage." **Fig. 5.**—The "nine-lobe stage." All figures × 150.

somewhat different from that of the description of this Desmid, given by Carpenter and Hogg.[1]

These authors state that the divisions are made in the following order, 1, 3, 5, 7 and 13, and that it takes place in about three and one-half hours.

Now, the time occupied by my specimen in multiplying from 5 to 7 was three-quarters of an hour, but, if I have been clear in my description, the enlargement and subsequent division of No. 3 (Figs. 2 and 4) must have continued, and have been completed, before 2 and *2a.* (Fig. 4) could have undergone the same process.

This being the case we should have had 1, 2, *2a*, 3, *3a*, (Fig. 5), or nine processes in all, or in other words, *one more stage* than is described by the authors referred to.

Both, however, seem to have drawn their inspiration from a paper read by E. G. Lobb, before the Microscopical Society of London—not then Royal,—in 1861, and hence their descriptions agree.

For many years, I had the pleasure of being personally acquainted with Mr. Lobb, and, having spent many hours in his company, I knew him to be a careful observer.

I am therefore at a loss to account for the discrepancy.

One other fact makes it still more difficult, and that is, if you allow three-quarters of an hour for the divisions, and assume them to be 1, 3, 5, 7, 9 and 13, you have exactly three and one-half hours.

On the 20th of June I placed ten or twelve specimens in a special tank for the purpose, if possible, of solving my difficulty. But although I examined them almost every evening for two months, and could see their numbers increase to about forty, and could frequently perceive them in the last, or almost completed stage, I have not been fortunate enough to see the beginning, or the middle stage. The denticulation does not appear with the division of the lobes, but is probably coincident with the enlargement of the newly-formed portion of the desmid, which is not at first so large as the original.

[1] This species is also described as M. rotata (Grev.) Ralfs by Wolle and Cooke.

THE GENUS ELEOCHARIS IN NORTH AMERICA.

BY N. L. BRITTON, PH. D.

(*Read October 18th*, 1889.)

The Cyperaceous genus *Eleocharis* was proposed by Robert Brown in 1810, in his famous "Prodromus Floræ Nova Hollandiæ," where several Australasian species are first described and a large number of others, formerly known as *Scirpi*, are stated to belong to the new genus. Since that time it has been very generally accepted by systematic botanists as distinct from *Scirpus*, although Dr. Asa Gray appears to have been in some hesitation concerning this for he has described one species as *Scirpus* (*Eleocharis*) *Wolfii*. While otherwise closely allied it is here maintained that all the species may at once be known from the unispicate *Scirpi*, by the style-base forming a persistent tubercle, not confluent with the body of the achene, as it is in the otherwise nearly related species of the other genus.

The American forms have not been critically studied since 1836, when Dr. Torrey's monograph on North American Cyperaceæ was published, in the 3rd volume of the Annals of the New York Lyceum of Natural History. Nineteen species of *Eleocharis* are there recognized, including one now referred to *Scirpus* (*E. pygmæa*, Torr.). Seven of these nineteen were described as new and six of them have stood the test of 53 years' study. To these 18 species of Torrey we may now add 22, for I find that I can individualize 40 as North American. Of these, four only have not yet been collected in the United States, one of them (*E. geniculata*) not coming north of S. Mexico so far as I am informed, the others extending to Central Mexico. The United States may thus claim 36 species, or double the number known to Dr. Torrey in 1836.

The morphology of the genus may be thus summarized : The roots are either fibrous and annual or they are accompanied by perennial rootstocks and thus serve as characters in grouping species ; the stems are simple columns, ranging from less than an inch to nearly three feet in height and in section they are terete, wing-angled, nodose or flattened ; the leaves are represented only by sheaths or vaginæ, which terminate at their orifices in short teeth, in a truncate border, or in some sharply defined species in scarious spreading borders ; the stems are

abundantly supplied with stomata, and thus are the physiological equivalent of the comparatively greater leaf-surface of other plants.

The flowers are borne in a several or many-flowered spike at the summit of the stem ; this spike consists of scales or glumes more or less densely imbricated, and behind each scale is a perfect flower, with the occasional exception that the lowermost scales are empty ; the flower consists of a perianth composed of from three to nine bristles, which are generally barbed downwards, and differ greatly in length in the different species, in some being entirely absent and the flower thus quite incomplete ; in most species there are normally three stamens, but this is a variable character, and of but little value in classification, for there may be fewer in a very large number of species ; these stamens have flattened filaments as a general rule, a feature hared by many other Cyperaceæ ; there is a single pistil with a simple style which divides near its apex into either two or three stigmatic lobes, and this is so good a character as to be taken as the mark of primary division of the genus into the subgenera Eleogenus with two-cleft style, and Eueleocharis with three-cleft style ; it is further found that almost invariably the former have flattened or lenticular achenia, while those of the latter are triangular ; the surface of the achenium is smooth in some species, ribbed in others and again cancellate in others and these markings are quite persistent ; the thickened style-base or tubercle, is of extremely differing forms and many species can be determined at a glance from an examination of this alone.

On these morphological characters I have entirely depended in the grouping of the species here presented. I am not unaware that histological details have been invoked in the classification of this natural order, and I have been particularly impressed by the extremely minute and laborious researches of Palla as published in Engler's Bot. Jahrb. x. 293, but as the results reached by him appear to me to destroy natural alliances rather than to ascertain them, I have not used the arrangement of the fibro-vascular bundles of the stem as proposed by him, nor, indeed, have I found it necessary to invoke it.

In point of geographical distribution the species are most abundant in our southeastern states. Of the 36 species 24 occur in Florida, and Texas is almost as well supplied. Several

appear to be extremely local, but as these plants are but little studied by collectors, it is not safe to assert that this is actually the case. Five of our species are also natives of the Old World, three being of general sub-tropical distribution and two of circum-boreal range.

Two species by recent American authors referred to this genus (*E. pygmæa*, Torr. and *E. pauciflora*, Link) are remanded to *Scirpus* where they originated as *Scirpus nanus*, Spreng. and *S. pauciflorus*, Lightf. The one is a denizen of salt marshes on both sides of the continent, occurring also in similar situations in the Old World, and the other is a high mountain and arctic plant, also common to both hemispheres.

My studies on the genus, which have been extended over several years, have been most pleasantly facilitated by the kindness and courtesy of Mr. C. B. Clarke, F. L. S., of the Royal Herbarium at Kew, who is now engaged in monographing the order Cyperaceæ for the "Monographiæ Phanerogamorum," edited by the immortal DeCandolles. I have had the pleasure of much personal consultation with Mr. Clarke, and he has further favored me with numerous letters and notes, besides giving me freely a list of the species as recognized by him. The following enumeration is arranged as nearly as possible on his forthcoming work, differing only in some points where I have not been able fully to agree in his conclusions. I take this opportunity of expressing to him my grateful thanks for all his many favors.

My gratitude is also due my many friends who have liberally supplied me with specimens for study and examination. They are almost too numerous to mention at this place, but I must indicate to Professor Porter, Dr. Watson, Mr. Coville, Mr. Redfield, Mr. Canby and Mr. Martindale the great advantages I have derived from the study of the material at their command.

SUB-GENUS LIMNOCHLOA.

1. E. INTERSTINCTA (Vahl), Rœm. & Schult., Syst. Veg. ii. 148 (1817).

   Scirpus interstinctus, Vahl, Enum. Pl. ii. 251 (1806).

   Scirpus plantagineus, Sw. Fl. Ind. Occ. i. 123 (1797), not of Retz.

Scirpus obtusus, Spreng. Syst. i. 204 (1825), not of Willd.
Eleocharis equisetoides, Torr. Ann. Lyc. N. Y. iii. 296 (1836).
Eleocharis Ellioti, Dietr. Syn. Pl. i. 190 (1839).
Scirpus equisetoides, Ell. Sk. i. 79 (1821).
Scirpus geniculatus, Pursh. Fl. Amer. Sept. i. 55 (1814), not of Linn.

Sneach Pond, Cumberland, R. I., Olney; Wellesley, Mass., Morong; near Lewiston, Del., Nuttall; Salisbury, Md., Canby; eight or ten miles from the village of Jacksonburgh, Mich., in a small lake called Sand Lake, J. Wright; Wilmington, N. C., McCarthy; Santee Canal, S. C., Ravenel; Florida, Chapman; Valley of the lower Rio Grande, Buckley; W. Texas, Wright, 707; in water, borders of the San Felipe, Bigelow, Mex. Bound. Survey, 1524; Ocean Springs, Miss., Tracy, 91.

Vera Cruz, Mexico, Mueller, 2146; Cuba, Wright, 710, 709 in part, and also, in part, under the name *Sc. polygamus*, Wr.; Martinique, Hahn, 546.

The synonym of Pursh doubtfully referred here by Dr. Torrey (Ann. Lyc. iii. 297), can hardly be applied to any other species. Kunth (Enum. Pl. ii. 154), attributes the binomial to R. Brown, but that author says only (Prodr. Flora Nov. Holl. i. 224) that *Scirpus interstinctus*, Vahl, belongs to his genus *Eleocharis* there first propounded. Rœmer & Schultes (loc. cit.) refer it to themselves, and it appears to me, rightly. The same is true of many other species. Bœckeler (Linnæa, xxxvi. 474) refers the species to *E. plantaginea* a widely distributed Indian species but Mr. Clarke concludes that they may always be separated by the characters afforded by the achenia, although otherwise much alike, and in this conclusion I fully agree.

2. E. MUTATA (L.), Rœm. & Schult. l. c. 155 (1817).
Scirpus mutatus, L. Amœn. Acad. v. 391 (1760).
Scirpus quadrangulatus, Michx. Fl. Bor. Amer. i. 30 (1803).
Scirpus marginatus, Muhl. Gram. 28 (1817).
Scirpus albomarginatus, Rœm. & Schult. Mant. ii. 74 (1824).
Eleocharis quadrangulata, Rœm. & Schult. Syst. Veg. ii. 155 (1817).
Heleocharis spiralis, Bœckl. Linnæa, xxxvi. 473 (1870), not R. & S.

For the same reason given under the last species, this binomial should not be attributed to Robert Brown but to Rœmer & Schultes.

Presque Isle, Erie, Penn., Garber, Mertz ; outlet of Oneida Lake, N. Y., Curtiss ; Paddy's Lake, Oswego Co., N. Y., Wibbe ; Flint, Mich., Clarke ; Swartswood Lake, Sussex Co., N. J., Porter ; Johnson's Pond, Dennisville, Cape May Co., N. J., Parker, Diffenbaugh ; Cape May, Brinton ; Milford, Kent Co. and in Newcastle Co., Del., Canby ; Townsend, Del., Commons ; bank of the Schuylkill below Gray's Ferry, Penn. 1863, Porter ; Virginia and Alabama, Buckley ; North Carolina, Curtiss, McCarthy ; New Orleans, La., Ingalls ; Prairies near Indianola, Texas, Ravenel ; ponds, Grand Prairie, Dallas Co., Texas, Reverchon, 1683 ; Allenton, Mo., Letterman ; Hempstead, Texas, E. Hall, 695 ; St. Louis, Mo., Engelmann ; Abbeville, La., Langlois.

Mexico, Mueller, 1367 ; Guadalahara, Palmer, 1886, No. 431 ; Pringle, 2061 ; Guatemala, Tuerckheim, 1283 (named by me *Heleocharis spiralis*); Orizaba, Botteri, 756.

Cuba, Wright, 3376. Santo Domingo, Herb. U. S. Comm. Inquiry, 597.

Certain of the more northern specimens have larger achenia with more spongy tubercles than those from the south.

3. E. CELLULOSA, Torr. Ann. Lyc. N. Y. iii. 298 (1836).

Scirpus dictyospermus, Sauv. Fl. Cuba. 174 (1868).

Appalachicola, Fla., Chapman ; Chattahoochee and Duck Key and shore of Pensacola Bay, Fla., Curtiss, 3080 ; Palm Creek, Fla., Curtiss, 183 ; Miami, Fla., Garber ; Key West, Blodgett ; salt sandy marsh, Bay of St. Louis, La. (the original station), Ingalls ; Ocean Springs, Miss., Tracy ; Rutersville, Texas, and Plantae Texanae, 708, Wright ; Flora Texana exsicc., 719, Lindheimer ; Bay of St. Louis, Miss., and Pointe à la Hache, La., Langlois, 142 ; Mex. Bound. Survey, 1525. Reported also by McCarthy in the Wilmington Flora from North Carolina, but his specimen in Herb. Canby is *E. mutata*.

Cuba, Wright, 3763.

4. E. ROBBINSII, Oakes in Hovey, Mag. Hort. 1841, 1(published May 6th).

E. tortilis, Torr. l. c. 314, not of Schultes.

Kendrick's Lake and Potter's Lake near St. Stephen, New Brunswick, Vroom; Pondicherry Pond, Jefferson, N. H., Robbins fide Oakes, l. c.; Plymouth and Manchester, Mass., Oakes; Tewksbury, Mass., B. D. Greene; Cranston, R. I., Olney; Guilford, Conn., Bishop Catalogue; Pine Plains, Dutchess Co., N. Y., Hoysradt; Wading River, Long Island, N. Y., E. S. Miller; Aquebogue, Long Island, H. W. Young; a few miles west of Manchester, Ocean Co., N. J., Torrey; Quaker Bridge, Burlington Co., N. J., Parker; Pleasant Mills and Dennisville, N. J., Diffenbaugh; Forked River, N. J., Britton; Canterbury, Md., and Ellenville and Fulton, Del., Canby; Quincy, Fla., Chapman; near Jacksonville, Fla., Keeler.

5. E. ELONGATA, Chapm. Fl. S. States, 514 (1860).

Appalachicola, Fla., Chapman; Everglades, Dade Co., Fla., Garber; Texas, Nealley. Very closely related to the last. I have seen ripe fruit on the specimen collected by Mr. Nealley in Texas, preserved in the National Herbarium.

SUB-GENUS ELEOGENUS.

(*A*) *Ochreatæ.*

6. E. OCHREATA, Nees, Linnæa, ix. 294 (1835), name only.

Eleogenus ochreatus, Nees in Mart. Fl. Bras. ii. (I.) 102 (1842).

Scirpus ochreatus, Griseb. Fl. Brit. W. I. 570, (1864).

Eleocharis capitata, Chapm. Fl. S. States, 518 in part (1860).

Eleocharis albovaginata, Bœckl.

Scirpus anisochætus, Sauvalle, Fl. Cuba. 174 (1868).

Eleocharis, Wats. Proc. Amer. Acad. xviii. 170.

Appalachicola, Fla., Chapman; Tampa, Fla., Garber; swamps near Mosquito Inlet and Tampa, Fla., Curtiss, 3076, distributed as *E. capitata*; in hot water, Yellowstone Park, Tweedy, 222; Mud Springs, Montana, Hayden Survey, communicated by Prof. Porter and named by Mr. Clarke; Mobile, Ala., Mohr.

Cuba, Wright, 711, 712 in part, also as Nos. 218 and 219 in part; Martinique, Hahn.

San Luis Potosi, Mex., Schaffner, 575 in part; near Coban, Guatemala, Bernouilli, 811.

7. E. MACULOSA (Vahl), Rœm. & Schult. l. c. 154 (1817).

Scirpus maculosus, Vahl. Enum. ii. 247 (1806).

Texas, Berlandier, 2090 in Herb. Delessert, also in Mexico, all according to Mr. Clarke. I have not seen anything from North America that I could refer to this species; No. 2090 of Berlandier is *E. capitata* in both the Torrey and Gray herbaria.

8. E. OLIVACEA, Torr. Ann. N. Y. Lyc. iii. 300 (1836).

Miry borders of Bristol Pond, Vt., Pringle; Amherst, Mass., Jesup; Plymouth, Mass., Oakes, Tuckerman; Dedham, Mass., Hitchings; North Providence, R. I., Olney; Tewksbury, Mass., B. D. Greene; Shore of Lake Ontario, J. A. Paine; Presque Isle, Erie, Pa., Guttenberg, Garber; Shore of Bay of Quinte, Canada, Macoun, 1870; near Babylon, L. I., Torrey; Tottenville, Staten Island, Leggett; Lake Mohegan, N. Y., Leggett; Lawrenceville, N. J., Lanning; Tom's River and Quaker Bridge, Torrey; Brown's Mills, Martindale; Dover, Del., Canby; St. George, Commons; marshes on the sea islands, N. C., Curtiss; Alexandra, Burke Co., Ga., J. B. Ellis; Santee Canal, S. C., Ravenel; Deer Island, Miss., Tracy (?), specimens young, perhaps *E. maculosa*.

(*B*) *Capitatæ.*

9. E. CAPILLACEA, Kunth, Enum. Pl. ii. 139 (1837).

Seen by Mr. Clarke from Georgia, Chapman, Herb. Mus. Brit., and from North Carolina, Chapman, Herb. Boissier; not seen by me from the United States.

Cuba, Wright, distributed as *Anisostachya decipiens.* First described from Brazilian specimens.

A very well marked species with the long, scarious lower glumes of the spikelet enclosing all the rest, only a single nut ripening from each spikelet.

10. E. ATROPURPUREA (Retz), Kunth, l. c. 151 (1837).

Scirpus atropurpureus, Retz, Obs. v. 14 (1789 ?).

Eleocharis multiflora, Chapm., Fl. S. States, 517 (1860).

For additional synonymy of this wide-spread tropical species see Kunth, l. c., and Clarke, Journ. Bot. xxv. 269 (1887).

West Florida, Chapman; Key West, Dr. John Ridell, 1839, ex herb. C. Mohr; Blanco, Texas, Reverchon, 1672; New Mexico, Wright, 1961, 1930 and 1932; Mex. Bound. Survey, 1527a in part; near Greeley, Colo., Greene, in Herb. Gray.

11. E. CAPITATA (Willd.), R. Br. Prodr. Fl. Nov. Hol. 225 (1810) and presumably of Linnæus, Sp. Pl. (1753).
Scirpus capitatus, Willd. Sp. Pl. i. 294 (1797).
Eleocharis dispar, E. J. Hill, Bot. Gaz. vii. 3 (1882).

Key West, Fla., Blodgett; Miami, Fla., Garber; Mobile, Ala., Mohr; Whiting, Lake Co., Ind., E. J. Hill; Deer Island, Miss., Tracy, 143; sandy banks of the Pierdinalis, Texas, Reverchon, 1673; New Mexico, Wright, 1933; Texas, Wright, 711, Nealley; Southwestern Texas, E. Palmer, 1328; Agua Caliente, borders of Colorado Desert, Parish, 1160; Oregon, E. Hall, Herb. Gray.

Mexico, Berlandier, 680, 2090; Vera Cruz, Mueller, 2148; Mirador, Muller, 373, 112; Guaymas, Palmer, 635, 635½; Yiquana, Lower Cal., Orcutt.

Guadaloupe, Dr. Madiana; Cuba, Wright, 712; Santo Domingo, Eggers, 2470; U. S. Comm. Inquiry, 587.

The extensive range which the above-cited localities indicate would appear to show that this species may be more common than we now know it to be. Dark glumed forms are with difficulty separable from *E. ovata.* Dr. Torrey reports it from Georgia, but there are now no specimens of it from that state in his herbarium, nor have I been able to trace his var. *β* (Ann. Lyc. iii. 305); the plant referred by me to this (in Bull. Torr. Club, xi. 87,) is *E. albida*, which long headed forms of the present species closely simulate.

12. E. OVATA (Roth), Rœm. & Schultes, Syst. ii. 152 (1817).
Scirpus ovatus, Roth, Catl., i. 50 (1797).
Scirpus capitatus, Walt. Fl. Carol, 70 (1788), not of Willd.
Scirpus obtusus, Willd. Enum. Hort. Berol. i. 76 (1809).
Eleocharis obtusa, Schultes, Mant. ii. 89 (1824).
Eleocharis diandra, C. Wright, Bull. Torr. Club, x. 101 (1883).

Common throughout eastern North America, extending to New Brunswick, Fowler; Florida and Texas; Lincoln, Neb., H. J. Webber; Agassiz and Pitt River, British Columbia, Macoun; Multnomah Co., Oregon, Howell, 409; San Bernardino, A. Wood (?).

Not reported from the Rocky Mountain region.

The style of this species is occasionally three-cleft.

Var. GIGANTEA, Clarke, MSS. Oregon, Lyall.

Var. ENGELMANNI (Steud).

E. Engelmanni, Steud. Syn. 79 (1855); Gray in Patterson's Cat. Oquawka Plants and Bot. Gaz. iii. 81; Watson, Bot. Cal. ii. 222; Britton, Bull. Torr. Club, xv. 100.

E. obtusa, var. b, Torr. Ann. Lyc. iii. 303 (1836).

Weathersfield, Conn., C. Wright; hills in Waltham, Mass., B. D. Greene; Winchester, Mass., C. E. Faxon; Pine Hill, Medford, Mass., C. W. Swan; Camden, N. J., Martindale; Kingwood, Hunterdon Co., N. J., Best; Washington, N. J., Britton; Ringing Rocks, Bucks Co., Penn., Ruth; Tinicum, Delaware Co., Penn., Porter; Delaware, Canby; Mississippi bottoms near Oquawka, Ill., Patterson; Lafonte, Ind., E. J. Hill; St. Louis, Mo., Engelmann; Little Rock, Ark., Coville; Texas, Wright; California, Lemmon.

After examining all the specimens of this interesting plant that I could secure and having had the satisfaction of seeing it growing, I find practically nothing but the elongated spike to separate it from *E. ovata*, although some may consider this sufficient. A monstrous form of what may be this species, having a capitate cluster of spikes has been collected by Dr. C. W. Swan, at Winter Pond, Winchester, Mass.

(*C*) *Palustres.*

13. E. PALUSTRIS (L.), Rœm. & Schultes, Syst. Veg. ii. 151 (1817).

Scirpus palustris, L. Sp. Pl. 70 (1753).

Eleocharis uniglumis, Schultes, Mant. ii. 88 (1824); Torrey, Ann. Lyc. iii. 301 (1836).

Throughout North America.

Flat-stemmed specimens of this species from Missouri and Texas have been called *E. compressa*. They may represent a distinct variety.

Var. GLAUCESCENS (Willd.), Gray, Man. 5th Ed. 558 (1867).

Scirpus glaucescens, Willd. Enum. 76 (1809).

Eleocharis glaucescens, Rœm. & Schultes, Mant. ii. 89 (1824).

Eleocharis calva, Torr. Fl. N. Y. ii. 346 (1843); a form destitute of bristles.

Throughout eastern North America and the Rocky Mountain region; not seen by me from the Pacific coast.

Mr. Clarke has concluded to hold this up as a species, but in this I have not been able to agree.

Var. WATSONI (C. C. Babington), Clarke, Journ. Bot. xxv. 268 (1887).
Eleocharis Watsoni, C. C. Babington, Ann. Nat. Hist. (II.) v. 10 (1852).

Stated by Mr. Clarke (l. c.) to occur in Newfoundland, Labrador and subarctic America, and (in litt.) to be a very trifling depauperate form or variety with a castaneous spike.

As recognized by me this has been collected at Brackley Point, Prince Edward Island, Macoun; Hudson's Bay, Burke.

Var. VIGENS, Bailey, in Herb. Gray. Culm stout, thick, very spongy, constricted at the summit nearly as thick as the ovate spike.

Rocky Mountains, Nuttall; Niagara River, N. Y., Clinton; Huntington Valley, Nevada, Watson, 1210; shore of Lake Champlain, Highgate Springs, Vt., H. G. Jesup.

14. E. NODULOSA (Roth), Schultes, Mant. ii. 87 (1824).
Scirpus nodulosus, Roth, Nov. Plant. Spec. 29 (1821).
Eleogenus nodulosus, Nees in Mart. Fl. Bras. ii. 104 (1842).

In brooks, Santa Catalina Mts., Arizona, Pringle; swamps, Abbeville, La., Langlois.

Coban, Guatemala, Tuerckheim, 1266; Mirador, Mex., Liebmann; Cuba, Wright, 3374 in part.

SUB-GENUS EUELEOCHARIS.

(*A*) *Scirpidium.*

15. E. ACICULARIS (L.), Rœm. & Schultes, Syst. Veg. ii. 154 (1817).
Scirpus acicularis, L. Spec. Pl. 71 (1753).
Scirpus trichodes, Muhl. Gram. 30 (1817).
Chætocyperus urceolatus, Liebm. Mex. Halvg. 243 (1849).

Throughout North America, extending into Mexico.

Var. MINIMA, Torr. MSS. Culms 5–15 mm. high, densely cæspitose; achenium smaller than in the type, ribbed and cancellate; bristles none. Torrey Herb., ex. Herb. Olney, 1872; Oregon, E. Hall, 566. This may be a species.

Var. RADICANS (Poir).

Scirpus radicans, Poir. Encycl. vi. 751 (1807 ?).
Eleogiton radicans, Dietr. Sp. Pl. i. 192 (1839).
Eleocharis radicans, Kunth, Enum. ii. 142 (1837).

Texas, Lindheimer, 315 in part, Herb. Kew; E. Meyer; also seen from California (Bolander, 6233); Mexico and Guatemala (Tuerckheim, 391) by Mr. Clarke. Written up by Dr. Torrey as var. *nana*, and by Mr. Clarke as var. *Lindheimeri*, but the published name of Poiret should be maintained.

16. E. CANCELLATA, S. Wats. Proc. Amer. Acad. xviii. 170 (1883).
E. Schaffneri, Bœck. Engler's Bot. Jahrb. 1886, 274.
Eleocharis acicularis, a small form, Torr. Mex. Bound. Surv., 228 (1859).

New Mexico, Wright, 1937; San Luis Potosi? Schaffner, 204. Parry and Palmer, 912.

17. E. BONARIENSIS, Nees in Hook. Journ. ii. 398 (1840).
Eleocharis striatula, Desv. in Gay. Fl. Chil. vi. 173 (1854).

Orizaba, Mueller, 1973. Not yet detected in the United States. Its range is southward along the western coast of South America.

18. E. WOLFII, A. Gray, Proc. Amer. Acad. x. 77 (1874).

Athens and Canton, Ill., J. Wolf.

Mr. Clarke finds this species hardly distinct from the preceding.

(*B*) *Chætocyperus.*

19. E. CHÆTARIA, Rœm. & Schultes, Syst. ii. 154 (1817).
Heleocharis triflora, Bœckl. Flora, 1880, 437 (fide Clarke).

For synonymy see Hemsley, Bot. Biol. Cent. Amer. iii. 455. Mexico, Guatemala (Tuerckheim, 900, det. C. B. Clarke; Bernouilli, 7), and the West Indies; not yet detected in the U. S.

20. E. VIVIPARA; Kunth, Enum. ii. 146 (1837). Hardly of Link, according to Mr. Clarke.
Eleocharis prolifera, Torr. Ann. Lyc. N. Y. iii. 442 (1836), not of p. 316.

Florida, Chapman, Rugel; low grounds in Tampa, and Jacksonville, Fla., Curtiss, 6 and 3088; Indian River, Fla., Curtiss,

3072 in part (Distr. as *E. albida*); also seen by Mr. Clarke from Carolina, Beyrich, 677 and Charleston, Cabanis, 356.

21. E. TORTILIS (Link), Schultes, Mant. ii. 92 (1824).

Scirpus tortilis, Link, Jahr. iii. 78, fide Schultes.

Scirpus simplex, Ell. Sk. i. 76 (1821).

Eleocharis simplex, Torr. Ann. Lyc. N. Y. iii. 306 (1836).

Fulton, Del., and Salisbury and Ocean City, Md., Canby; Wilmington, N. C., Curtiss; South Carolina, Elliott; Aiken, S. C., Ravenel; Alabama, Porter; Florida, Chapman; Alexandria, La., Hale; Texas, Wright in Herb. Gray.

22. E. TUBERCULOSA (Michx.), Rœm. & Schult. Syst. ii. 152 (1817).

Scirpus tuberculosus, Michx. Fl. Bor. Amer. i. 30 (1803).

Tewksbury, Mass., B. D. Greene; Manchester, Mass., Oakes; Salem, Mass., Dr. Pickering, fide Torrey; South Kingston, R. I., Olney; Long Island, State Flora; Erastina, Staten Island, Britton; Manchester, N. J., Porter; near Camden, N. J., C. E. Smith; Quaker Bridge, N. J., Torrey; Browns Mills and Batsto, N. J., Martindale; and generally frequent in southern New Jersey, and southward along the Atlantic coast, extending westward to New Orleans, La., Ingalls; and Texas, E. Hall, 699.

The var. β Torr. Ann. Lyc. l. c. 308, appears to me only as the large and luxuriant form of the species.

(*C*) *Leiocarpicæ.*

†*Capillaceæ.*

23. E. MINIMA, Kunth, Enum. ii. 138 (1837).

Mexico, fide Clarke.

I am unacquainted with this species.

24. E. PROLIFERA, Torr. Ann. Lyc. N. Y. l. c. 316 (1836).

North Carolina, Curtis; Charleston, S. C., B. D. Greene; Milledgeville, Ga., Boykin; Columbus, Ga., Boykin?; southern states, Herb. Baldwin; Florida, Chapman; Louisiana, Hale; near Covington, La., Langlois; Sink Hole Cr., Polk Co., Fla., J. Donnell Smith; pine barren exsiccated ponds, Wilmington, N. C., Curtis, not at all proliferous.

Mr. Clarke proposes to reduce this to a variety of the Cuban *E. camptotricha*, Sauv. Fl. Cub. 173 (1868); and doubtless with good reason, but that is a more recently published species, and

Torrey's specific name for it should stand. It is certainly distinct from *E. vivipara*, Kunth.

††*Leucocarpeæ.*

25. E. MICROCARPA, Torr. Ann. Lyc. l. c. 312 (1836).
Including var.? *filiculmis*, Torr. l. c. the stouter, northern form.
Eleocharis Torreyana, Bœck. Linnæa, xxxvi. 440 (1870).

Pine barrens of New Jersey, Torrey, Austin; Quaker Bridge, N. J., Eaton; Fulton and Ellenville, Del., and Salisbury, Md., Canby; North Carolina, Curtis; Barnwell District, and Santee Canal, S. C., Ravenel; Florida, Chapman, Rugel; Jesup, Ga., Curtiss, 3083; Alabama, Buckley; Mobile, Mohr; Montgomery, Ala., McCarthy; Louisiana, Hale; New Orleans, Ingalls (the type specimen); Ocean Springs, Miss., Tracy; Texas, Wright; prairies near Indianola, Texas, Ravenel; Texas, E. Hall, 697; Tiger's Point, La., and Bay of St. Louis, Miss., Langlois; Cuba, Wright, 3765. Some of Austin's New Jersey specimens are markedly proliferous, and others from the South exhibit this feature in a lesser degree.

26. E. BICOLOR, Chapm. Fl. S. States, 517 (1860).

Quincy, Fla., Chapman, 1836; Santee Canal, S. C., 1848, Ravenel. Not since collected.

27. E. BALDWINII (Torr.), Chapm. l. c. 519 (1860).
Chætocyperus Baldwinii, Torr. Ann. Lyc. l. c. 295 (1836).

Low places near St. Mary's, Ga., Baldwin; East Florida, Leavenworth; Florida, Chapman; Miami and Tampa, Fla., Garber; Jacksonville, Fla., Curtiss, 3074; East Florida, Palmer, 596; Hibernia, Fla., Canby. Often proliferous.

28. E. SULCATA (Roth), Nees, Linnæa, ix. 294 (1835), name only and in Mart. Fl. Bras. i. 98 (1842) under *Scirpidium sulcatum*.
Scirpus sulcatus, Roth, Nov. Pl. Sp. 30 (1821).
Limochloa calyptrata, Liebm. Mex. Helv. 56 (1850).
Eleocharis calyptrata, Steud. Syn. 81 (1855).
Heleocharis Rothiana, Bœckl. Linnæa, xxxvi. 444 (1870).

Vera Cruz, Mexico, Mueller, 2149, 2150, fide Hemsley; Guatemala near Coban, Bernouilli, 801; Tuerckheim, 1383, 429.

†††*Montanæ.*

29. E. MELANOCARPA, Torr. Ann. Lyc. l. c. 311 (1836).

Plymouth, Mass., Oakes, Tuckerman; Providence, R. I., Olney; Long Pond, Wading River, Long Island, Miller, Knieskern ; near New Dorp, Staten Island, Britton ; pine barrens of New Jersey, Parker ; near Savannah, Ga., Baldwin (the type specimen) ; Florida, Chapman, Rugel ; Walton Co., Fla., Curtiss, 3082 ; Hibernia, Fla., Canby.

30. E. BOLANDERI, A. Gray, Proc. Amer. Acad. vii. 392 (1868).

Sequoia Grove, Mariposa Co., Cal., Bolander, 4689 ; "in the Sierra Nevada, near snow," Greene, fide Watson, Bot. Cal. ii. 222 ; but the specimen in Herb. Gray from that station is too young for determination. Closely allied to the last.

31. E. TRICOSTATA, Torr. Ann. Lyc. l. c. 311 (1836).

Newcastle, N. Y., C. A. Hexamer ; Wading River, Long Island, Miller ; Quaker Bridge, N. J., Knieskern ; Tinicum, Delaware Co., Penn., A. H. Smith ; Santee Canal, S. C., Ravenel ; Georgia, LeConte ; Florida, Chapman, Rugel.

32. E. ALBIDA, Torr. Ann. Lyc. l. c. 304 (1836).

Eastville, Va., Canby ; Piney Point, Md., Vasey ; Sullivan's Island, S. C., Ravenel ; Georgia and Florida, Baldwin ; Appalachicola, Fla., Chapman ; shores of St. John's River, Curtiss, 3072 ; near New Orleans and Barataria, La., Ingalls ; Herbarium Texano-Mexicanum, Berlandier, 3226, 2425 and 995 ; valley of the lower Rio Grande, Buckley ; Plaqueminas, La., Langlois, 146a.

Var. BERLANDIERI (Clarke). Stouter than in the type, with longer heads, and the tubercle slightly more rostrate. Mr. Clarke considers this a species.

Berlandier, Herb. Tex.-Mex. 995, 2435 ; Nueces Bay, six miles north of Corpus Christi, Texas, Ravenel.

33. E. TENUIS (Willd.), Schultes, Mant. ii. 89 (1824).
Scirpus tenuis, Willd., Enum. Pl. Hort. Berol. i. 76 (1809).

Cape Breton, Nova Scotia, Macoun; Rhode Island, Olney, and southward through the Middle and Southern States, extending west to Dakota, as at Devil's Lake, Nicollet, and Lake Winnipeg, Macoun ; and to Texas, E. Hall, 698 ; Langlois, 1684.

34. E. ACUMINATA (Muhl.), Nees, Linnæa, ix. 294 (1835).
Scirpus acuminatus, Muhl. Gram. 27 (1817).
Eleocharis compressa, Sulliv. Sill. Jour. (I.) xlii. 50 (1842).

Wet limestone rocks, Buffalo, N. Y., Clinton ; Dexter, N. Y., Vasey; Keeweenaw Point, Mich., Robbins; near Columbus, Ohio, Sullivant ; Augusta, Ill., Mead ; Presque Isle, Erie, Penn., Garber, Mertz ; Jupiter River, Anticosti, Macoun ; near Jackson, East Feliciana, Carpenter ; wet prairies, Louisiana, Hale ; islands in Potomac River, Mont. Co., Md., Smith ; also what appears to be the same from Mt. Lincoln, Colo., J. M. Coulter in Herb. Porter ; Belleville, Ontario, Canada, and Nepigon, Macoun ; Illinois, Wolf ; Washington, D. C., Ward; Belleville, Ont., Macoun ; mountains of Georgia, Chapman ; along Moose Jaw Creek, Assiniboia and Porcupine Mts., Manitoba, Macoun. Perhaps this is to be better considered a variety of *E. tenuis.*

35. E. MONTANA (H. B. K.), Rœm. & Schultes, Syst. ii. 153 (1817).

Scirpus montanus, H. B. K. Nov. Gen. i. 226 (1815).

Eleocharis Dombeyana, Kunth, Enum. ii. 145 (1837).

Eleocharis arenicola, Torr. in Engelm. & Gray, Bost. Journ. Nat. Hist. v. 237 (1847).

Eleocharis truncata, Schlecht. Bot. Zeit. 118 (1849).

E tenuis, var. *β*. Torr. Ann. Lyc. l. c., probably.

Sullivan's Island, S. C., Ravenel ; Appalachicola, Fla., Chapman ; Palm Creek, west of Everglades, Fla., Curtiss, 3073 ; Galveston, Texas, Lindheimer, 205 ; Wright, 713 ; Austin, Texas, E. Hall, 696 ; Mississippi, Drummond ; New Orleans, La., Drummond, 408 ; Pointe à la Hache, La., Langlois, 144 ; New Mexico, Wright, 1958, 1959 ; California, Coulter, 799 ; San Bernardino, Cal., G. R. Vasey, 653 ; Parish, 2082 ; Santa Barbara, Cal., Mrs. R. F. Bingham, 489 (distrib. as *E. Bolanderi*); California, Rothrock, 58 (distrib. as *E. palustris*) ; San Diego Co., Cal., E. Palmer, 386.

San Luis Potosi, Mexico, Schaffner, 577; Mexico, Liebmann.

††††*Rostratæ.*

36. E. CYLINDRICA, Buckley, Proc. Acad. Nat. Sci. Phila. 1862, 10.

E. tenuis, A. Gray, l. c. 168.

Heleocharis Texana, Britton, Bull. Torr. Club, xi. 87 (1884). Texas, Buckley.

When I described this species as new, I supposed that Dr. Gray's reference of Mr. Buckley's species to *E. tenuis* satisfac-

torily removed that name from further consideration, but on comparison with Mr. Buckley's specimens preserved at Philadelphia, I find that there is no doubt of their identity. It is remote from *tenuis*.

37. E. INTERMEDIA (Muhl.), Schultes, Mant. ii. 91 (1824).
Scirpus intermedius, Muhl. Gram. 31 (1817).

Near Hamilton College, Oneida Co., N. Y., Gray; Herkimer Co., N. Y., Paine; Jefferson Co., N. Y., Crawe; Pine Plains, Dutchess Co., N. Y., Hoysradt; Pennsylvania, Muhlenberg; Dillerville Swamp, Lancaster Co., Penn., Porter; Pennsylvania Furnace, Huntingdon Co., Penn., Boecking in Herb. Porter; meadows of Huntingdon Co., Lowrie in same; Bethlehem, Penn., Rau; Lake Grinnell, Sussex Co., N. J., Porter; Springfield, Ohio, Lea; Columbus, Ohio, Riddell; Jackson, Mich., J. Wright; Illinois, Brendel; Ringwood, Ill., Vasey; Belleville, Ontario, and Bay of Quinte, Macoun; Minnesota, T. J. Hale; Michigan, Herb. Gray.

38. E. ROSTELLATA, Torr. Fl. N. Y. ii. 347 (1843).
Including var. *occidentalis*, Watson, Bot. Cal. ii. 222 (1880).
Scirpus rostellatus, Torr. Ann. Lyc. iii. 318 (1836).

Providence, R. I., Olney; South Kingston, R. I., Congdon; Vermont, Tuckerman, fide Gray; Gratiot City, Mich., Hb. Gray; Penn Yan, N. Y., Sartwell (the type specimen); Bergen swamp near Buffalo, N. Y., Clinton; Atlantic City, Cape May and Dennisville, N. J., Parker; New Durham and on the Hackensack meadows, N. J., Allen; Crawford Co., Penn., McMinn in Herb. Porter; Collin's Beach, Del. and Wilmington, N. C., Canby; South Carolina, Dr. Walsh; Miami, Fla., Garber; Texas, Wright, 709; Mex. Bound. Survey, 1528; New Mexico, Wright, 1931, 1956; Yellowstone Park, Letterman; Soda Springs, Nev., Schockley, 280; Albuquerque, N. M., Tracy; Southern California, Parry and Lemmon, 398; salt marsh, west side of Suisan Bay, Cal., Greene (a robust form with large achenia); Vancouver, Macoun; Huachuca Mts., Ariz., Lemmon, 2907½; Sta. Inez Mts., Mrs. Cooper, 124;
Sonora, Mexico, Thurber; Cuba, Wright, 3769, in Herb. Kew as "*E. nodulosus*, Roth."

39. E. PARISHII, spec. nova. Culmis cæspitosis, setaceis, teretibus, basi vaginatis; vaginæ truncatæ, unidentatæ; radix

fibrosa?; spica lanceolata, angusta, acutata, castanea, 1 cm. longa, 2 mm. lata; squamis ovatis, obtusis, subcarinatis, apiculatis, margine hyalinis; achenio elliptico, trigono, lævi, nitido, cum tuberculis 1 mm. longo; tuberculis angustis, calyptratis, rostratis; setis circiter 4, albidis, achenium æquantibus.

Agua Caliente, San Diego Co., Cal., S. B. Parish, April, 1882, No. 1569.

The material is insufficient for a positive assertion that this has always fibrous roots. Mr. Parish has very obligingly divided his only specimen with me and until the plant is again collected its further characters must remain uncertain.

40. E. GENICULATA (L.), Rœm. and Schult. Syst. ii. 224 (1817). *E. densa*, Benth. Pl. Hartw. 27 (1839). A terete-stemmed variety.

Mexico, Mueller, 1762; Guatemala, Coban, Tuerckheim, 544; Panama, Dr. J. M. Bigelow.

Widely distributed in tropical America, probably not reaching the United States.

NOTE ON CALOTERMES MARGINIPENNIS, LATR.

BY P. H. DUDLEY, C. E.

(*Presented October 4th*, 1889.)

In my former Paper on the "Termites, or the so-called White Ants of the Isthmus of Panama" I mentioned that Dr. H. A. Hagen had identified three genera, viz., *Termes*, *Eutermes* and *Calotermes*, the latter genus being represented by only one species, *Calotermes marginipennis*, Latr., which was found destroying the white-ash door-posts of the coaches of the Panama Railroad Company. Since that announcement, large numbers of the same species have been found in the coaches, not only destroying the door-posts, but the seat-rails as well. In one coach, twelve seats were so badly injured as to require renewal.

The life-history and habits of the *Calotermes* differ widely from those of the *Termes* and *Eutermes*, except possibly in destroying wood. The *Calotermes* can eat hard, dry wood. Choice, hard-wood furniture being especially relished.

So far, on the Isthmus, the *Calotermes* have not shown any evidence of constructing exterior galleries, or even of eating, or breaking through the surfaces of the wood, which they are destroying. Their presence in the wood is not easily detected, as most of the wood is consumed as food. The wood is excavated, or mined in rooms, or chambers, their greatest length being in the longitudinal diameter of the fibres. The entrance to the rooms is on one side, and about one-sixteenth of an inch in diameter—just sufficient for one insect at a time to enter. The *Calotermes* have no workers, and have only about one per cent. of soldiers, so far as observed, on the Isthmus. Only one entrance to a room, or chamber, requires far less soldiers to guard the chambers, than it does the long galleries of the *Termes* and *Eutermes*.

The queens of the *Calotermes*, which have been captured on the Isthmus, are small, but the number is large. No evidence has yet been found of constructed nests. The eggs are carried far in the excavated chambers, in the wood. The males and females have wings, at one stage of their life-history, and they probably swarm, although this has not been witnessed.

Near the beach, at Colon, there is a large Coccoloba, or Sea-Grape tree, the bark of which has been pierced in many places by the larva of some insect, of a nature entirely different from that of the Termites. In these small excavations in the bark, Mr. Beaumont has found many pairs of *Calotermes marginipennis*, some little families of *Eutermes*, and three more species of *Calotermes*. Some of the pairs had two or three eggs, and others had larvæ.

Mr. Beaumont prepared ash blocks, about one and one-quarter inches square, and three inches long, making a small excavation on one side. Then he transferred, from the bark of the Coccoloba, several pairs of *Calotermes marginipennis*, each to a distinct block, and placed a glass slide over the excavation, enclosing the insects. Several of the eggs so transferred hatched, and some of the larvæ metamorphosed to nymphæ, and the latter metamorphosed to the imago. By the observation of these, many points in the life-history of *Calotermes* have been obtained.

How the *Calotermes* can eat hard, dry wood is better understood from these observations. The larvæ are fed for some

time. Then they cut their own food. But, in time, their mandibles become worn and dull. When metamorphosis takes place, the new form has a pair of new and sharp mandibles, and the wood cutting can be renewed. The nymphæ also dull their mandibles. The imago has at first a new pair of mandibles, and can cut hard wood. When these mandibles become dull, then a supply of food must be cut for the imago by those having sharper mandibles.

PROCEEDINGS.

Meeting of May 3d, 1889.

The meeting was held in the Lecture-Room of the Chemical Department of the School of Mines, Columbia College.

The President, Mr. Charles F. Cox, in the chair.

Thirty-nine persons present.

Prof. Edw. G. Love addressed the Society on "Photomicrography." Prof. Love gave a rapid sketch of the history of Photography from its first beginnings, making special reference to its use in producing representations of microscopic objects.

The description of the needed apparatus took the following form :—

1. Sources of illumination, in the order of their value. The methods for obtaining monochromatic light, by means of the prism, or the ammonio-sulphate of copper solution, were here explained.

2. The Microscope. Regarding the stand, the speaker explained that a short tube, which must be lined with black velvet to prevent all internal reflection, and be used without an eye-piece, would give the best results ; that a mechanical stage was very desirable, as well as a sub-stage, for holding an achromatic condenser, when using high powers.

3. The Focusing Screen. A ground-glass screen would answer, when sun-light was used with low powers. But some finer surface would be found necessary with other sources of illumination, and with the use of moderate to high powers. Among the substitutes employed, a dry plate, which had been slightly exposed, and then bleached after being developed and fixed, would afford a very good surface. But the best screen, unquestionably, was

one of plate-glass, the focusing of the image being accomplished by the aid of a magnifier.

4. The Objective. The ordinary microscope-objective was not desirable. Because in it the visual and chemical foci were not coincident, although it could be used, by making the necessary allowance after focusing the object, which allowance could be ascertained by experiment. An objective especially corrected for this work would be found much more satisfactory.

By the use of the lantern, a series of views, illustrating the development of the construction of various forms of apparatus, was projected upon the screen and explained. These illustrations had been secured by using a portrait-lens, when a low magnification was desired, and Carbut's "B" plates, with the pyro. or oxalate developer, and also orthochromatic plates in special instances.

Prof. Louis H. Laudy then addressed the Society upon the use of the Arc-Electric Light, in the projection of the images of microscopic objects, detailing the difficulties to be surmounted.

After explaining the working of the apparatus, Prof. Laudy gave a demonstration of the superiority of this method of illumination. By way of comparison, projection of the image of a microscopic object was made to alternate with that of a lantern-slide of the same object, shown with the lime-light, to the manifest advantage of the arc-light, even under these trying circumstances.

This alternate projection of the images of object and lantern-slide served forcibly to illustrate the relative actinic and non-actinic properties of certain colors in the object, and the cases in which the orthochromatic plate could be used to advantage.

A large number of photomicrographs, representing a great variety of subjects, were also exhibited for inspection.

Meeting of May 17th, 1889.

In the absence of the President and the Vice-President, Mr. J. D. Hyatt was elected Chairman.

Twenty persons present.

The Microscope—A Zentmayer Army-Hospital binocular stand—donated to the Society by the late Benjamin Braman was brought to the Society's rooms by Mr. John L. Wall.

On motion it was *Resolved:* That the subject of the Braman Microscope be referred to the Board of Managers, with power to have engraved upon the Microscope words commemorative of its donation to the Society by Benjamin Braman; and also with power to acknowledge, in such manner as they may deem best, to the proper persons, the receipt of the Microscope by the Society.

Mr. J. D. Hyatt gave notice of the meeting of the American Society of Microscopists.

OBJECTS EXHIBITED.

1. *Liostephania rotula:* by E. A. SCHULTZE.

2. *Pleuro-staurum fulmen:* by E. A. SCHULTZE.

Nos. 1 and 2 being Diatoms from Sorata, Bolivia.

3. *Plumatella repens*, one week old, reared in an aquarium: by STEPHEN HELM, 417 Putnam Ave., Brooklyn, N. Y.

4. *Melicerta ringens*, branched: by STEPHEN HELM.

5. A crustacean parasite of fish, *Argulus* sp., prepared by Mr. Norman N. Mason, Providence, R. I.: by J. L. ZABRISKIE.

6. Section of Flint from Tennessee, containing the body of a silicious sponge, with the structure perfectly preserved: by J. D. HYATT.

7. Larva of *Corethra plumicornis:* by F. W. LEGGETT.

8. Section of Wing of Butterfly, showing structure of the scales and their attachment: by L. RIEDERER.

THE CRUSTACEAN PARASITE, ARGULUS.

The Corresponding Secretary presented the following communication upon his exhibit—the Crustacean Parasite, *Argulus*, sp., prepared and loaned for the occassion by Mr. Norman N. Mason, of Providence, R. I.:—

"Huxley, in his 'Anatomy of the Invertebrated Animals,' says in effect that Argûlus is a parasite common upon the Stickleback, and is of very curious modification. It is extremely flattened, has a styliform weapon lying in a sheath in front of the mouth, and six pairs of appendages, the anterior pair being metamorphosed into suckers.

"Mr. Mason says of this beautifully prepared specimen, that it was captured swimming near the shore in Cunliff's Pond, in the City of Providence. And that it would adhere to the inner surface of a glass beaker, by means of the suckers on its ventral

portion, with such tenacity that a stream of water, one-quarter of an inch in diameter, from the city supply and at a pressure of sixty pounds to the inch, even when directed against its side, would fail to dislodge the curious creature. He has searched in vain for any similar specimens upon fish taken from the same pond."

CLEANING DIATOMS FROM SAND.

The Corresponding Secretary presented the following communication upon this subject, also from Mr. Norman N. Mason:—

"After removal of the organic matter with acid, by the usual methods, add to the diatoms and sand in a large bottle thirty, forty or fifty times the quantity, by measure, of water, and gently shake until they are mixed. This water, with the diatoms and sand kept suspended by an occasional shake, is slowly poured in a small stream upon the upper end of a strip of clean glass, three feet long by three inches wide and securely supported. The upper end of the glass should be from one-eighth to one-quarter of an inch higher than the lower end, and the glass should be level transversely. Beneath the lower end place any convenient receiver. The water and diatoms will pass into the receiver. The sand, which will form little bars on the glass, must be removed occasionally, as it gradually creeps towards the lower end of the glass, and there would eventually pass into the receiver.

"The loss of diatoms will be very small. Usually one pouring is sufficient for cleaning. The sand can be re-washed if necessary, or a little clear water, run over the sand on the glass strip, will carry forward almost the last diatom ; but this will scarcely pay for the trouble. A short piece of glass will cause a failure, and too great an incline will be found almost as bad."

"NORMAN N. MASON,
Providence, R. I."

MEETING OF JUNE 7TH, 1889.

The President, Mr. Charles F. Cox, in the chair.

Nineteen persons present.

Messrs. Charles Adams Coombs and J. Egmont Schermerhorn were elected Resident Members of the Society.

OBJECTS EXHIBITED.

1. Consecutive sagittal sections through the head of *Utethesia bella*, L.: by L. RIEDERER.

2. Fossil seeds of *Chara* from the Tertiary of the Isle of Wight: by GEO. E. ASHBY.

3. Buhrstone from the Paris Basin, with seeds of *Chara in situ*: by GEO. E. ASHBY.

4. Sections of Fossil Seeds of *Chara*: by JAMES WALKER.

5. Section of a Conglomerate from Vesuvius, resembling Pisolite in structure, being composed of large grains, which, in turn, are composed of smaller grains, the whole being cemented by a carbonate of lime, in which are marine shells. This formation is from the ejected ashes, and shows that the sea has access to the volcano, thus confirming the latest theory relating thereto: by J. D. HYATT.

6. *Conochilus volvox*;

7. *Melicerta tubicularia*;

8. *Opercularia stenostoma*;

9. *Actinosphærium Eichornii*;

10. *Floscularia ornata.*

Nos. 6–10 exhibited by Stephen Helm, 417 Putnam Ave., Brooklyn, N. Y.

MEETING OF JUNE 21ST, 1889.

In the absence of the President and the Vice-President, Mr. Charles S. Shultz was elected Chairman.

Nineteen persons present.

Mr. Walter H. Mead, Chairman of the Committee on Memorial of the death of Mr. Benjamin Braman, reported that such Memorial had been furnished to the Committee on Publications.

On motion, the Committee on the Memorial was discharged with thanks.

OBJECTS EXHIBITED.

1. Plumose Mica, from Canada: by A. WOODWARD.

2. Amazon Stone, from Pikes Peak, Col.: by A. WOODWARD.

3. Oligoclase, from 119th St. and 5th Ave., New York City: by A. WOODWARD.

4. *Sporangites Huronensis*, from the Chicago Tunnel, Ill.: by A. WOODWARD.

5. Section Upper Jaw of Cat, showing teeth *in situ:* by CHARLES S. SHULTZ.

6. Section Upper Jaw of Mole, showing teeth *in situ:* by CHARLES S. SHULTZ.

7. Diatoms from Staten Island: by E. A. SCHULTZE.

8. Diatoms from Tuscarora, Soundings, 3,000 fathoms: by E. A. SCHULTZE.

9. *Triceratium Hardmanianum:* by E. A. SCHULTZE.

10. *Surirella Febigerii:* by E. A. SCHULTZE.

PUBLICATIONS RECEIVED.

The American Monthly Microscopical Journal: Vol. X., Nos. 6–8 (June–August, 1889).

The Microscope: Vol. IX., Nos. 6–8 (June–August, 1889).

The Microscopical Bulletin and Science News: Vol. VI., Nos. 2–4 (April–August, 1889).

Bulletin of the Torrey Botanical Club: Vol. XVI., Nos. 7, 8 (July, August, 1889).

The School of Mines Quarterly: Vol. X., No. 4 (July, 1889).

The San Francisco Microscopical Society: Proceedings, June 12–August 28, 1889.

Natural Science Association of Staten Island: Proceedings, June 13, 1889.

Anthony's Photographic Bulletin: Vol. XX., Nos. 13–16 (July 13–August 24, 1889).

The Botanical Gazette: Vol. XIV., Nos. 6–8 (June–August, 1889).

Entomologica Americana: Vol. V., No. 7 (July, 1889).

Insect Life: Vol. I., No. 12—Vol. II., No. 2 (June–August, 1889).

The Journal of Mycology: Vol. V., No. 2 (June, 1889).

Cornell University College of Agriculture; Bulletins: 5–8 (April–August, 1889).

Michigan State Board of Agriculture: Twenty-seventh Annual Report (1888).

Agricultural College of Michigan: Bulletins, Nos. 49–51 (May–July, 1889): Annual Catalogue (1889).

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Journal Trenton Natural History Society: Vol. II., No 1 (January, 1889).

Journal Cincinnati Society of Natural History: Vol. XII., No. 1 (April, 1889).

The West American Scientist: Vol. VI., Nos. 44–46 (June–August 1889).

Psyche: Vol. V., Nos. 157–159 (May–July, 1889).

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The Brooklyn Medical Journal: Vol. III., Nos. 7–9 (July–September, 1889).

The Indiana Medical Journal: Vol. VII., No. 12—Vol. VIII., No. 3 (June–September, 1889).

The Hahnemannian Monthly: Vol. XXIV., Nos. 7–9 (July–September, 1889).

The Electrical Engineer: Vol. VIII., Nos. 91–93 (July–September, 1889).

The National Druggist: Vol. XIV., No. 12—Vol. XV., No. 5 (June 15–September 1, 1889).

The American Lancet: Vol. XIII., Nos. 7–9 (July–September, 1889).

The Pacific Record of Medicine and Surgery: Vol. III., No. 11—Vol. IV., No. 1 (June–August, 1889).

The Mining and Scientific Review: Vol. XXII., No. 23—Vol. XXIII., No. 9 (June 13–September 5, 1889).

The Satellite: Vol. II. (May, 1889).

The Annual of the Universal Medical Sciences: Vols. I.–V. (1889).

The Canadian Record of Science: Vol. III., No. 7 (July, 1889).

The Ottawa Naturalist: Vol. III., No. 2 (July–September, 1889).

The Journal of the Royal Microscopical Society: June, 1889. Part 3.

The Journal of the Quekett Microscopical Club: Vol. IV., No. 25 (July, 1889).

The Journal of Microscopy and Natural Science: Vol. II., Part 7 (July, 1889).

Grevillea: Vol. XVII., No. 84 (June, 1889).

Proceedings of the Bristol Naturalist's Society: Vol. VI. Part 1 (1888–89).

Belfast Naturalists' Field Club; Annual Report and Proceedings: Vol. III., Part 1 (1887–88).

The Naturalist: Nos. 168–170 (July–September, 1889).

Penzance Natural History and Antiquarian Society; Report and Transactions (1888–89).

The Victorian Naturalist: Vol. VI., Nos. 1–3 (May–July, 1889).

Royal Society of New South Wales; Journal and Proceedings: Vol. XXII., Part 2 (1888).

Société Royale de Botanique de Belgique: Comptes-Rendus (June 16, 1889); Bulletin, Vols. XXVI.–XXVIII (1887–9).

Académie D'Hippone, Bone: Comptes-Rendus (December 15, 1888).

Jahresbericht der Königl. Böhm. Gesellschaft der Wissenschaften, Prag (1888); Sitzungsberichte (1888); Abhandlungen, Vol. VII., Part 2 (1887–88).

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Naturwiss. Verein des Regier. Frankfurt a O.; Monatliche Mitheilungen, Vol. VI., No. 10—Vol. VII., No. 2 (January–May, 1889); Societatum Litterae, Vol. II., No. 11—Vol. III., No. 3 (November, 1888–March, 1889).

Monatsblätter des Wissenschaftlichen Club in Wien: Vol. X., Nos. 9–11 (June 15–August 15, 1889).

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QUARTERLY.

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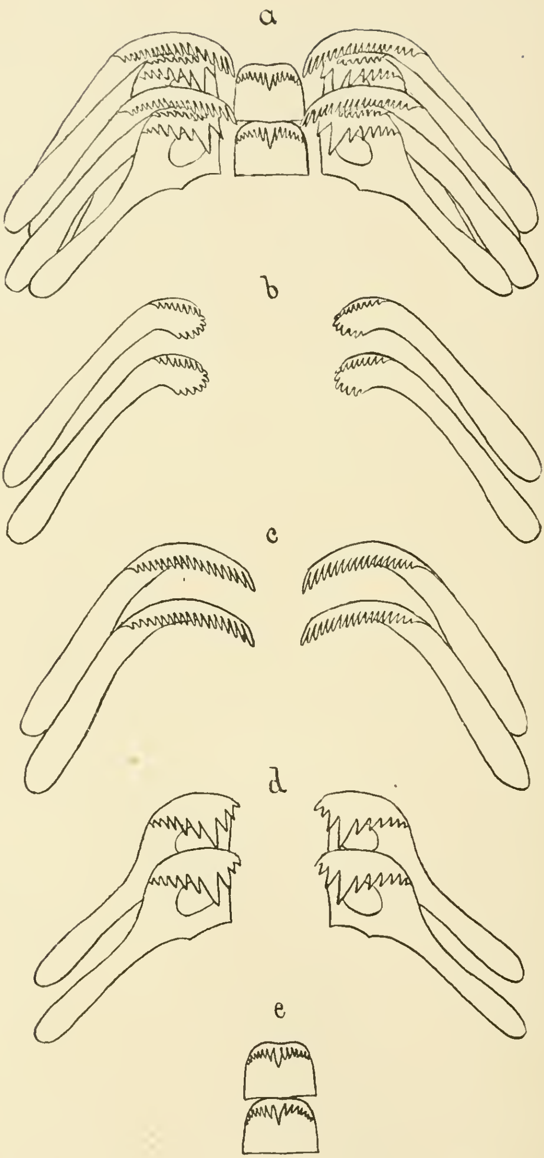


BEECHER ON PYRGULA.

JOURNAL

OF THE

NEW-YORK MICROSCOPICAL SOCIETY.

VOL. VI. JANUARY, 1890. No. 1.

ON THE LINGUAL DENTITION AND SYSTEMATIC POSITION OF PYRGULA.

BY C. E. BEECHER.

(*Read November 1st*, 1889.)

The genus *Pyrgula* has been so often assigned to various families of the mollusca by different authors, that it has had a truly remarkable experience. There now seems to be about an equal weight of opinion as to whether it should be placed in the family Rissoidæ or among the Melaniidæ. Without more definite information than that expressed by the shell, it appears merely a matter of choice as to which group should include the genus. This condition is but one of many, in which development in parallel lines produces forms having great similarity in external appearance, and in which recourse must be had to more important and reliable characters than external form, in order to ascertain their true systematic position.

True systematic data should, if possible, be based upon the assemblage of all the characters of the organism, and it is unsafe to take any one as infallible. In the present genus —*Pyrgula*, and among many similar small turreted and globular shells, as the Rissoidæ, which commonly vary within narrow limits, any important member of the animal which exhibits great

Explanation of Plate 21.

(*a*) Two members of the radula with the teeth in their normal position.

(*b*) The teeth of the second or outer pleural series; showing their spoon-like form

(*c*) The teeth of the first pleural series; carrying eighteen denticles each.

(*d*) The lateral teeth; showing the long slender peduncle, the quadrate body with an alveolus, and the curved serrula bearing ten denticles.

(*e*) Two of the rachidian teeth; showing their form and the arrangement of the denticles.

All figures magnified 500 diameters.

differentiation and is more diversified than the shell, naturally affords a more convenient and trustworthy basis for systematic determination.

Too great reliance may be often placed upon trivial differences in the lingual dentition, but it is believed that within reasonable limits, the characters of the odontophore are extremely serviceable for purposes of classification. Especially is this true for family distinctions, and on this account, such features are commonly recognized as of much, though not of sole, importance

The radula in the Rissoidæ is very characteristic, its principal diagnostic feature being the presence of basal denticles on the rachidian teeth. The accompanying illustration and description of this organ in *Pyrgula annulata*, C. & Jan. (*P. helvetica*, Mich.) the type species of the genus, show that basal denticles are not present on the rachidian tooth, and, therefore, it cannot properly be arranged with the Rissoidæ, but is related to the Melaniidæ.

The genus is at present unknown in North America, as the species which were originally ascribed to it have since been placed in other genera. The first American species thus referred was *Pyrgula scalariformis*, Wolf. (Am. Jour. Conch., vol. v. p. 198, pl. 17, f. 3, 1870) from the Post Pliocene of the Illinois river. This form is now believed to belong to the genus *Pyrgulopsis*, Call and Pilsbry.[1] In 1883, R. E. C. Stearns described a shell from Pyramid Lake, Nevada, and placed it in *Pyrgula* (*P. nevadensis*). The dentition of this form was described and figured by the writer in 1884,[2] but as, at that time, the true dentition of *Pyrgula* was unknown, no comparisons could be drawn, and the systematic position of the species remained unchallenged. Subsequently Call and Pilsbry (*loc. cit.*) proposed the genus *Pyrgulopsis* for this and allied species based upon conchologic features. The only difference in the shell noted is that *Pyrgula* is bicarinate or multicarinate, while *Pyrgulopsis* is characterized as a unicarinate form.

[1]On Pyrgulopsis, a new genus of Rissoid mollusk, with descriptions of two new forms. Proc. Davenport, Acad. Nat. Sci., Vol. V. 1886.

[2]Call and Beecher. Notes on a Nevada shell (*Pyrgula nevadensis*). *American Naturalist*, vol. xviii., pp. 853, 854. 1884.

PYRGULA, Christofori and Jan, 1832.

Type, *Melania helvetica*, Michelin, 1831.
= *Pyrgula annulata*, Christ. & Jan, 1832.

Lingual dentition. The number of longitudinal rows of teeth is seven, arranged 3-1-3, after the formula (15-18-10)-15 +(10-18-15).

The rachidian tooth is longitudinally semi-elliptical, with the sides nearly at right angles to the line of the base. Serrula abruptly curving forward, and bearing about fifteen denticulations. The central denticle is the largest and most prominent. The lateral series diminish rapidly in descending order, so that the denticles on the sides of the tooth are very small.

Body of lateral tooth subquadrate, with an angular projection at the basal margin, and a subovate thin alveolus in the central portion. Peduncle slender. Serrula with ten denticles; the fourth from the inner end of the series is much the largest.

The first pleural has about eighteen denticles on the serrula. The second is spoon-shaped, and bears about fifteen denticles.

The shell from which the radula was obtained for this description is from Italy. It was kindly furnished the writer by Wm. H. Dall, Honorary Curator Department of Mollusks, U. S. National Museum.

AMPLIFICATION IN MICROMETRY.

BY HON. MARSHALL D. EWELL, LL. D.

(*Read December 20th*, 1889.)

My attention has quite recently been drawn to this subject in connection with the celebrated "Dr. Cronin case." It may be taken for granted that one cannot measure what he cannot see. But how high an amplification is necessary in a given case is a matter of much importance. In the measurement of blood-corpuscles in medico-legal cases the late Dr. Richardson advocated the use of a very high power, viz.: a $\frac{1}{25}$ or $\frac{1}{50}$ objective. In my own measurements of blood-corpuscles I have out of respect to authority, always used a high power, from 1,500 to 1,800 diameters. Recent experience has, however, qualified my views upon the subject, and in the case of the comparison of the ultimate subdivisions of a micrometer, ruled on metal, I am now of the opinion, that practically the same result may be obtained by the use of a $\frac{1}{4}$ objective as with a $\frac{1}{18}$ or $\frac{1}{25}$.

In December, 1885, I commenced the investigation of the $\frac{1}{100}$ mm. spaces of "Centimeter A."; but was unable to finish it. Two series of measurements were then made with a Bausch & Lomb opaque illuminating objective, and a Bullock filar micrometer. Recently I have measured the same spaces with a Spencer $\frac{1}{10}$ and $\frac{1}{25}$, and with a Zeiss $\frac{1}{18}$. The results of these measurements are given in the table below, each correction being the mean of from three to twelve readings of the filar micrometer at each end of the measured space.

It will be observed that the agreement between the several series of the writer and the results obtained by Prof. Hilgard is quite close, the discrepancy being practically insensible.

Provided the amplification is sufficient to render the object to be measured of a sensible size, and to render the difference between the sizes of two objects visible, my own judgment is that little, if anything, is gained by the use of a power so high as to impair the definition, even though such impairment be but slight. Quite as much, in other words, is lost by impairment of definition as is gained by increase of amplification. The practical conclusion then is that no higher power should be used than is consistent with perfect definition.

Table of Measurements of "Centimeter A."

Date.	Objective.	Value of 1 div. of mic.	2d $\frac{1}{100}$ mm.	3d	4th	5th	6th	7th	8th	9th	10th	11th	Remarks.
Dec. 26 and 27, 1885.	$\frac{1}{4}$ Bausch & Lomb.	0.126 μ	+0.38 μ	−0.01 μ	+0.05 μ	−0.39 μ	+0.14 μ	+0.27 μ	−0.14 μ	−0.12 μ	+0.09 μ	−0.26 μ	Bullock filar micrometer and Smith's vert. illuminator.
Sept. 12, '89	$\frac{1}{18}$ Zeiss.	0.01651 μ	+0.36	+0 02	+0.06	−0.42	+0.15	+0.28	−0.25	−0.07	+0.08	−0.21	Zentmayer filar micrometer and Smith's vert. illum.
" "	"	0.02166 μ	+0.33	0.00	+0.04	−0.41	+0.15	+0.25	−0.22	−0.14	+0.20	−0.22	Bullock filar micrometer and Smith's vert. illuminator.
Sept. 15, '89	$\frac{1}{25}$ Spencer.	0.02071 μ	+0.31	−0.05	+0.05	−0.43	+0.17	+0.32	−0.21	−0.06	+0.11	−0.19	Bullock filar micrometer and Smith's vert. illuminator. Collar correction = 10°.5.
" 18, '89	$\frac{1}{10}$ "	0.0401 μ	+0.32	+0.03	+0.03	−0.49	+0.16	+0.27	−0.18	−0.16	+0.20	−0.18	Bullock filar micrometer and Smith's vert. illuminator. Collar correction = 2 Rev. 0.¾.
" 19, '89	$\frac{1}{10}$ "	0.02561 μ	+0.36	−0.01	0.00	−0.47	+0.17	+0.25	−0.23	−0.05	+0.16	−0.18	Bullock filar, Smith's vert. illuminator and Bausch & Lomb amplifier. Cover correc. = 2 Rev. 0.¾.
		Mean.	+0.34	0.00	+0.04	−0.44	+0.16	+0.27	−0.22	−0.10	+0.15	−0.20	
Correction for error of total length..			+0.02	+0.02	+0.02	+0.02	+0.02	+0.02	+0.02	+0.02	+0.02	+0.02	This is $\frac{1}{10}$th correction for the 1st $\frac{1}{10}$ mm. = +0.20 μ.
Total correction......................			+0.36	+0.02	+0.06	−0.42	+0.18	+0.29	−0.20	−0.08	+0.16	−0.19	
Correction for same spaces as per report of Professor Hilgard......			+0.34	+0.05	+0.09	−0.41	+0.20	+0.39	−0.19	−0.05	+0.20	−0.18	

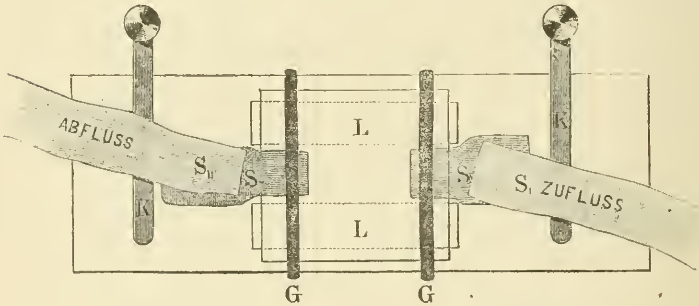
ON CULTIVATING LIVING ORGANISMS UNDER THE MICROSCOPE.

BY E. A SCHULTZE.

[Abstract and translation from an Article by Dr. John af Klercker in *Zeitschrift für Wissenschaftliche Mikroskopie*, vi. 2, p. 145 (1889).]

(*Read October* 18*th*, 1889.)

Any one, at all familiar with the microscopical study of living organisms, will have met with the difficulty of making a satisfactory examination, on account of the globular shape of the liquid containing the culture. It is well known that, in order to bring the objects to a full state of development, the water, especially in the case of algæ, must often be changed.



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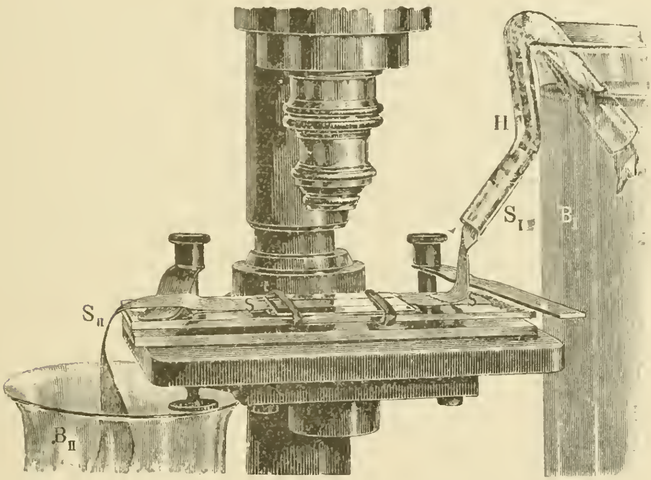
In doing this, it is in most cases difficult to prevent the algæ from changing their position under the cover-glass. Consequently a filament under observation may be lost to view. Sometimes, when a too sudden evaporation is feared, the volume of the drop must be increased to such extent that the high-power objectives, and especially the homogeneous immersion lenses, can only be used on those filaments which lie nearest to the cover-glass.

To obviate this difficulty I have been using an apparatus, the construction of which admits of a constant flow of water, and I find that it answers to my entire satisfaction in every

particular. Two strips, of equal length and breadth, say one inch long and one-quarter of an inch wide, cut from the ordinary square thin cover-glass, are cemented to a slide with Canada-balsam, as seen in Fig. 1, L, L. The object is now placed in a large drop of water between these two strips, under a one inch square cover-glass, and the entire capillary space



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may be filled, if necessary, by adding a few more drops of water.

Two short strips of linen, S, S, are now inserted, one at each end, and are held in position by two rubber bands, passing over the cover-glass and around the slide. In order to secure a flat surface on the under side, the slide is now cemented to another slide by means of two pieces of wax, equal in diameter to that of the rubber bands.

A glass (Fig. 2 B, 1.), reaching about three inches above the stage of the microscope, is filled with water, and a glass siphon inserted, the shorter arm of which has a much smaller opening than the longer. After filling the siphon with water, a strip of linen is gradually forced into the longer arm, till the flow of water is reduced to dropping. The linen strip is now cut the required length, and connected with one of the short pieces at

the side of the cover-glass. The water glass may be covered, to exclude any particles of dust. In this way a constant and steady flow of water is secured. The over-flow is carried, by means of another linen strip, from the opposite end of the cover-glass into a small receptacle at the foot of the microscope.

The following are the advantages of the apparatus :

1. A constant flow of fresh water, which may be regulated by the linen strip in the siphon. The water, while running, keeps saturated with oxygen, by means of the linen strip extending from the mouth of the longer arm of the siphon. This strip also acts as a filter, retaining any particles of dust, that may have accumulated in the reservoir.

2. The height of the capillary space between the cover-glass and the slide being only of the thickness of an ordinary cover-glass, all objects may easily be seen with an immersion lens.

3. The immersion fluid may be removed from the cover-glass without disturbing the objects.

PROCEEDINGS.

Meeting of October 4th, 1889.

The President, Mr. Charles F. Cox, in the chair.

Thirty persons present.

The Recording Secretary read a Paper, presented by Mr. P. H. Dudley, and entitled "Note on *Calotermes marginipennis*, Latr." This Paper is published in the Journal, Vol. V., p. 111.

Mr. Stephen Helm, of No. 417 Putnam Avenue, Brooklyn, N. Y., read a Paper, entitled, "Note on the binary subdivision of *Micrasterias denticulata* (Breb.), Ralfs," illustrated by blackboard sketches and an exhibit, as announced below. This Paper is published in the Journal, Vol V., p. 93.

OBJECTS EXHIBITED.

1. Spores of the Fungus, *Ustilago utriculosa*, Tul., on *Polygonum Pennsylvanicum*, L.: by J. L. Zabriskie.
2. Spores of the Fungus, *Ustilago Austro-Americana*, Speg., on *Polygonum Pennsylvanicum*, L.: by J. L. Zabriskie.
3. Insect eggs, arranged: by Charles S. Shultz.
4. Transverse section of ovary of the Poppy: by Charles S. Shultz.
5. *Volvox stellatus*, Wolle: by William G. De Witt.
6. Two forms of the same, with changed color: by William G. De Witt.
7. Foot of the Beetle, *Chrysochus auratus*: by F. W. Leggett.
8. Two hairs from the foot of the same: by F. W. Leggett.
9. *Micrasterias denticulata* (Breb.), Ralfs: by Stephen Helm.
10. *Plumatella repens*: by Stephen Helm.
11. *Lophopos crystallinus*: by Stephen Helm.

Mr. Zabriskie stated concerning his exhibits, that these fungi infest the same species of plant, *Polygonum Pennsylvanicum*. *Ustilago utriculosa*, as its specific name indicates, causes the fruit of the host to enlarge like a bladder—externally smooth and of a leaden hue, internally a mass of dark purple spores.

These spores are ornamented with prominent ridges, forming pentagons and appearing at the contour of the spore like the cogs of a gear-wheel. *U. Austro-Americana* affects the fruit, stems and leaves of the host. It sometimes causes the whole spike of the host to become a red, hardened, distorted, varnished mass. The spores are spherical, have the surface furnished with delicate spines, and ooze out in tendrils, which latter are sometimes one-half of an inch in length. This last species was described by Spegazzini, of the Argentine Republic, and was not reported from our Eastern States until these specimens were collected in 1888. Both species were abundant at Flatbush, L. I., in that year, but they have been comparatively scarce during this year.

Mr. Leggett said that his exhibit of the foot of the beetle, *Chrysochus auratus*, showed how the insect is able to walk inverted upon glass. The foot looks like a hair-brush, being furnished with numerous hairs, which are evidently provided at the end with a sucker.

Meeting of October 18th, 1889.

In the absence of the President and the Vice-President, Mr. William Wales was elected President *pro tem.*

Twenty-nine persons present.

Mr. J. Beaumont was elected a Corresponding Member, and Messrs. Henry F. Crosby and Bashford Dean were elected resident members of the Society.

Mr. E. A. Schultze read a Paper, which was an abstract and a translation from an article by Dr. John af Klercker, in *Zeitschrift für Wissenschaftliche Mikroskopie*, vi., 2, p. 167 (1889), entitled "On cultivating living organisms under the Microscope." This Paper was illustrated by black-board sketches, and is published in this number of the Journal, p. 6.

Mr. Schultze also gave an abstract and translation of an article by Dr. S. Apáthy, in the same number of the same publication, p. 171, as follows :

"A NEW CEMENT FOR GLYCERINE MOUNTS.

"In using asphaltum with glycerine mounts, it is preferable, and in most cases necessary, to first prepare a wax cell, which is afterwards covered with the cement, especially if the object

be a larger one than usual. Asphaltum will, moreover, only adhere to well-cleaned glass, and may crack with time. Canada-balsam, which always makes a hard and well-adhering frame, may never dry where it comes in contact with the glycerine, and, if the glycerine layer be not very thin, it will gradually enter under the cover-glass in the shape of a cloudy mass. A glycerine mount framed in Canada-balsam is never safe. It may last for a year or more, but it will eventually deteriorate, as has been my sad experience to witness.

"The cement I have prepared can be used without fear of any of these difficulties occurring. It is composed of equal parts of hard paraffine (melting point 60° C.) and Canada-balsam. They are melted together in a porcelain evaporating dish, and then kept heated over a moderate flame until the mass becomes of a golden color, and emits no more turpentine vapors. When cold the mixture is hard, but it can be readily warmed for use."

Mr. Schultze also gave notice of diatomaceous material found by a fisherman, in the month of June last, floating in the Pacific Ocean, two miles off the coast of Santa Monica, California, and stated that the material was now under examination to ascertain if it contained the same forms as those in the original "Santa Monica Find."

Dr. N. L. Britton read a Paper, entitled "The genus *Eleocharis* in North America." This Paper was illustrated by black-board sketches, and by a series of herbarium specimens and mounts as announced below, and is published in the JOURNAL, Vol. V., No. 4, p. 95.

OBJECTS EXHIBITED.

1. New and old mandibles of *Calotermes marginipennis*, Latr., and cast skin of the nympha of the same. Prepared by J. Beaumont, Colon, S. A.: Exhibited by P. H. DUDLEY.

2. Egg—one day after laying—of *Diplax Berenice*: by L. RIEDERER.

3. Larva of the same, five days old : by L. RIEDERER.

4. Seeds of *Eleocharis mutata* (L.), Rœm. & Schult.: by N. L. BRITTON.

5. Seeds of *E. capitata* (Willd.), R. Br.: by N. L. BRITTON.

6. Pigeon-post film, used in the Franco-Prussian war: by J. D. HYATT.

7. Spores of *Isoetes Englemanni*, Braun: by J. D. HYATT.

MEETING OF NOVEMBER 1ST, 1889.

The President, Mr. Charles F. Cox, in the chair.

Thirty-four persons present.

Mr. Charles S. Shultz introduced to the Society Miss Mary A. Booth, of Longmeadow, Mass., who was present as a visitor.

The President read a Paper, entitled "On the lingual dentition and systematic position of *Pyrgula*," and presented by Mr. Charles E. Beecher, a Corresponding Member of the Society. This paper is published in this number of the JOURNAL, p. 1.

OBJECTS EXHIBITED.

1. Diatoms of the genus *Aulacodiscus*, 29 forms and 19 species; prepared by Möller: by E. A. SCHULTZE.

2. Diatoms of the genus *Aulocodiscus*, 110 forms and 36 species; prepared by Thum: by E. A. SCHULTZE.

3. Fungus affecting shrimp in an aquarium: by F. W. LEGGETT.

4. Diatoms, from Bay of Bengal.

5. Diatoms, from Sandai, Japan.

6. Diatoms, from cementstein of Sandai, Japan.

7. Diatoms, from material found floating two miles off the coast of Santa Monica, California, June, 1889.

8. Diatoms, *Stephanodiscus careonensis* and *Melosira solida*.

9. Diatoms, from Rodondo Beach, California.

These six slides—Nos. 4–9 inclusive—were prepared and exhibited by Miss Mary A. Booth, and were donated by her to the Cabinet of the Society.

On motion, the thanks of the Society were tendered Miss Booth for this donation.

Mr. Leggett stated that he had kept shrimp for the space of four months in an aquarium, and that the fungus exhibited by him was now becoming very destructive to them. Usually a shrimp would die in one night after the appearance of the filaments of the fungus upon its body.

Meeting of November 15th, 1889.

The President, Mr. Charles F. Cox, in the chair.

Forty persons present.

Mr. Charles E. Pellew, E. M., delivered an Address on "The Microscopical and Other Tests for Blood." This Address was illustrated by many chemical experiments, conducted by Mr. Pellew, and by many exhibits, under the direction of Dr. George C. Freeborn and Messrs. G. Müller, C. C. Carmalt and C. F. W. McClure, as announced below.

OBJECTS EXHIBITED.

1. Fresh human blood, in "Holman's Current-slide:" by Charles F. Cox.
2. Circulation of blood in lung of Frog: by Dr. George C. Freeborn.
3. Circulation of blood in mesentery of Frog: by Dr. George C. Freeborn.
4. Human blood in Leucocythæmia, excess of white cells, the number of red cells being reduced by bacteria.
5. Human blood showing *Plasmodium malariæ* in malarial fever.
6. Blood showing *Bacillus* of anthrax.
7. Hæmoglobin crystals from human blood dried six months.
8. Hæmoglobin crystals from fresh blood of White Rat.
9. Blood of Black Bass, double stained.
10. Blood of Robin, double stained.
11. Blood of Frog, double stained.
12. Diluted human blood on a "Blood-cell Counter."
13. Fibrin from fresh human blood.
14. Continuous spectrum.
15. Spectrum of Oxy-Hæmoglobin.
16. Spectrum of reduced Hæmoglobin.
17. Spectrum of Limestone.

Exhibits, Nos. 4–17, inclusive, were under the care of Messrs. Müller, Carmalt and McClure.

Dr. Freeborn described "Thoma's Frog-plates," employed on the occasion.

The thanks of the society were tendered Dr. Freeborn and Messrs. Müller, Carmalt and McClure for their assistance in the matter of these exhibits.

PUBLICATIONS RECEIVED.

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The American Monthly Microscopical Journal: Vol. X., Nos. 9, 11 (September, November, 1889).

The Microscopical Bulletin and Science News: Vol. VI., No. 5 (October, 1889).

Bulletin of the Torrey Botanical Club: Vol. XVI., Nos. 9–11 (September–November, 1889).

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The Journal of Mycology: Vol. V., No. 3 (September, 1889).

Entomologica Americana: Vol. V., Nos. 5–9 (May–September, 1889).

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Boston Society of Natural History; Proceedings: Vol. XXIV., Parts 1, 2 (May, 1888–May, 1889).

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Cincinnati Society of Natural History; Journal: Vol. XII., Nos. 2, 3 (October, 1889).

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Meteoric Iron from Arkansas, 1886: By George F. Kunz.

Precious Stones: By George F. Kunz. 1888.

Mineralogical Notes: By George F. Kunz. 1888.

Two new masses of Meteoric Iron: By George F. Kunz. 1888.

Precious Stones in Canada and British America. By George F. Kunz. 1888.

Catalogue of Precious Stones of North America. By Tiffany & Co., New York. 1889.

Meteorites and what they teach us: By H. Hensoldt. 1889.

The Disposal of the Dead: By John M. Peacocke. 1889.

Wood's Lessons in Botany: A. S. Barnes & Co. 1889.

The Brooklyn Medical Journal: Vol. III., Nos. 10–12 (October–December, 1889).

Indiana Medical Journal: Vol. VIII., Nos. 4, 5 (October, November, 1889).

The Hahnemannian Monthly: Vol. XXIV., Nos. 10, 11 (October, November, 1889).

The Satellite: Vol. III. Nos. 1–3 (September–November, 1889).

The American Lancet: Vol. XIII., Nos. 10, 11 (October, November, 1889).

The Pacific Record of Medicine and Surgery: Vol. IV., Nos. 2–4 September–November, 1889).

The Electrical Engineer: Vol. VIII., Nos. 94–96 (October–December, 1889).

National Druggist: Vol. XV., Nos. 6–11 (September 15–December 1, 1889).

Mining and Scientific Review: Vol. XXIII., Nos. 9–20 (September 12–November 28, 1889).

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Grevillea: Vol. XVIII., No. 85 (September, 1889).

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Memorias de la Sociedad Cientifica "Antonio Alzate": Vol. II., Nos. 7, 9 (January, March, 1889).

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PROTOPLASM AND THE CELL DOCTRINE.

ANNUAL ADDRESS OF THE PRESIDENT, CHARLES F. COX, M. A.

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Truth, like the ocean, tends to a general level; but its surface is always ruffled by winds of speculation. All philosophy is either above or below the normal line of ascertained fact. A lack of knowledge keeps it in the trough of the sea; a superfluity of imagination carries it upward on the crest of the wave. In any case it holds a restless course, tossed hither and thither by the shifting breeze of opinion.

Every hypothesis starts from a point much lower than the actual truth-level, is pushed by the enthusiasm of its advocates far beyond the limit of rigid induction, and then, after many gradually weakening oscillations, is finally brought down to a state of nearly stable equilibrium by the force of logical gravitation.

Such has been, in part at least, the history of the hypothesis which has come to be known as the protoplasmic theory of life. The stream of doctrine which has resulted in this theory had its origin a little over fifty years ago, in a reaction from the then prevailing belief in a vital principle, or spiritual essence, which was not evolved by the parts or organs, but which entered into and took possession of the organism as a whole and caused it to live.

It would seem as if protoplasm must have come under the notice of the first serious worker with the microscope, although not

known by this name nor recognized for what it was afterwards seen to be. As early as 1755 Rosenhof described pretty clearly and correctly the curious phenomena of vitality as manifested in the movements of the "proteus animalcule" and seventeen years later Corti published his observations on the rotation in the cells of Chara. The similar process in Vallisneria was made known by Meyen in 1827, and in 1831 Robert Brown was overawing Charles Darwin with that "little secret," which proved to be his newly discovered cyclosis in the filaments of Tradescantia.

About the time that Corti was studying the formative material in Chara, Wolff, according to Professor Huxley, was trying to demonstrate, with reference to the higher animals, that "every organ is composed, at first, of a mass of clear, viscous, nutritive fluid, which possesses no organization of any kind, but is, at most, composed of globules."[1]

In 1835 Dujardin put forth his celebrated memoirs on the Foraminifera, in which he called attention to the "*substance animale primaire*," of which they are composed, which he described as "une sorte de mucus doué du mouvement spontané et de la contractilité," and to which he gave the name "*sarcode*."

But according to Doctor Drysdale, Doctor Fletcher, of Edinburgh, is entitled to the credit of first having given the *coup de grâce* to "the old hypothesis of a vital spirit, or essence, or principle as the cause of life," and of having framed a new theory "of the anatomical nature of the living matter which anticipates, in a remarkable manner, the discovery of the protoplasmic theory of life." In support of this claim we are referred to Doctor Fletcher's "Rudiments of Physiology," published in 1835, in which it was argued (1.) "that there can be no central vital influence communicable to the parts and dominating them, for the vitality of each must be inherent in itself, and, as a property of the material compound, cannot be transferred to the smallest distance; each part, organ, and even cell, therefore, possesses a quasi-independent life, and they are all bound together to form an individual merely by the ties of a central nervous system and common circulation, or some similar

[1] "The Cell Theory." By Thomas H. Huxley. Brit. and For. Med. and Chir. Review. October, 1853.

means when these are not present;" and (2.) "that the property of vitality does not reside equally in the various organic structures requiring such different physical properties, but is restricted solely to a universally-diffused, pulpy, structureless matter, similar to that of the ganglionic nerves and to the gray matter of the cerebro-spinal nervous system."[2]

As Doctor Drysdale remarks, "the progress of physiological knowledge from the time of Fletcher may be said to be bound up in the history of the cellular theory, which may be considered practically to have begun in 1838." But, as stated by Doctor Tyson, "it is evident that for some time prior to the year 1838, the cell had come to be quite universally recognized as a constantly recurring element in vegetable and animal tissues, though as yet little importance had been attached to it as an element of organization, nor had its character been clearly determined."[3]

It is to be noted, however, that nearly all the earlier observers dealt exclusively either with animal or with vegetable cells. It is probable that Schwann was the first to bring both animal and vegetable worlds under a general theory of cell-formation and growth; although Oken, as far back as 1808, had declared that "animals and plants are throughout nothing else than manifoldly divided or repeating vesicles." Oken, however, appears to have been engaged wholly with the morphological resemblances between the elementary parts of animals and plants, and, as Schwann himself remarks, "nothing resulted from such comparisons, because they were mere similarities in figure between structures which present the greatest variety of forms."

In 1837 Schleiden had made his discoveries as to the process of origination and development in vegetable cells and had, previous to publication, laid his conclusions before Schwann. In enumerating the substances composing the cell-contents Schleiden referred to a semi-granular substance occurring in irregular forms, having no internal structure, which was colored brown by tincture of iodine, and which he proposed to call mucus. He however distinguished another, still simpler mat-

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[2] "The Protoplasmic Theory of Life." By John Drysdale, M. D., F. R. M. S. London, 1874.

[3] "The Cell Doctrine: Its History and Present State." By James Tyson, M. D. Philadelphia; 2d. Edn., 1878.

ter, apparently a portion of the former, and in this respect seems to have anticipated some of the very latest developments of the protoplasm theory, of which I shali speak by-and-by, though his distinction of parts in the mucus came to be entirely overlooked when the whole granular mass afterwards received the name of protoplasm. He taught that "the youngest structures are composed of another distinct, perfectly transparent substance, which presents an homogeneous, colourless mass when subjected to pressure;" which, after pressure, "appears as colourless as before, and is so completely transparent as to be altogether invisible when not surrounded by coloured or opaque bodies." This he named vegetable gelatine. "It is this gelatine," he says, "which is ultimately converted by new chemical changes into the actual cellular membrane, or structures which consist of it in a thickened state, and into the material of vegetable fibre."[4] Here we have at least the root of the doctrine of germinal matter and formed material.

Now, taking Schleiden's observations for his starting-point, Schwann made an immense advance upon them, by using them as a key to the mysteries of animal development, and by deducing from them a new and far-reaching generalization. The task he took upon himself was to prove that "one common principle of development forms the basis for every separate elementary particle of all organized bodies, just as all crystals, notwithstanding the diversity of their figures, are formed according to similar laws." He sums up the matter by saying that "in the fundamental phenomena attending the exertion of productive power in organic nature a structureless substance is present in the first instance, either around or in the interior of cells already existing, and cells are formed in it in accordance with certain laws, which cells become developed in various ways into the elementary parts of organisms."[5]

From this time on, for ten or twelve years, the history of the cell doctrine is little more than a record of shifting views as to the relative importance of the cell-wall and the cell-contents. In the contest, however, the enclosing membrane was constantly

[4] "Contributions to Phytogenesis." By M. J. Schleiden. Sydenham Soc., 1847.

[5] "Microscopical Researches into the Accordance in the Structure and Growth of Animals and Plants." By Dr. Thomas Schwann. Translated by Hy. Smith. London, 1847.

losing and the enclosed plastic matter was constantly gaining in physiological significance. Even the nucleus was losing its essential character, so that when Cohn made known his observations on Protococcus Pluvialis,[6] the scientific world was ready to believe that the vegetative changes occurring in the cell-contents of this organism were brought about without the direct agency, if not actually in the absence, of any nucleus, whatever.

In 1844 Hugo von Mohl first applied the name protoplasm to the "opaque, viscid fluid of a white colour having granules intermingled in it," which he found filling the cells of plants.[7]

But now, in 1850, Cohn widened the boundaries of Schwann's great generalization by showing that there is not only a morphological similarity between the constituent cells of animals and those of plants but that there is a physiological analogy, if not also a chemical identity, between vegetable protoplasm and animal sarcode. He expressed the opinion that this common substance "must be regarded as the prime seat of almost all vital activity."

Up to this point the cell had been the only recognized vital unit, and the conception of an enclosing wall, semi-fluid contents, and a nucleus, as the essential and always present constituents, had been pretty generally insisted upon, although Cohn had partly disposed of the nucleus. *Omnis cellula e cellulâ* was still the orthodox tenet, when Leydig attempted to relegate the cell-wall to an incidental position as a mere hardened surface of the cell-substance, while retaining the nucleus as an indispensable centre of vitality, thus reducing the cell to "*protoplasm* inclosing a nucleus."[8]

In 1858 Professor Virchow abandoned the wall as an essential part of the cell, and gave in his adherence to the view that "a *nucleus* surrounded by a molecular blastema was sufficient to constitute a cell."[9]

But Doctor Tyson is disposed to award to Max Schultze "the credit of having fully overturned the vesicular idea of cells." Schultze, he says, in 1861, "insisted upon some modi-

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[6] Ray Society. 1853.

[7] "Principles of the Anatomy and Physiology of the Vegetable Cell." Translated by A. Henfrey. London, 1852.

[8] "Handbuch der Histologie." 1856.

[9] "Cellular Pathology." Translated by F. Chance. Philadelphia, 1863.

fication of prevailing views respecting the relation of cell-wall to cell-contents, and contended for a higher position for that part of the cell corresponding to the protoplasm of von Mohl, * * * * and showed how a careful study of the phenomena presented by the pseudopodia, extended by the various Rhizopods, might aid in clearing up the life of the elements of the cell. He also defined the cell as protoplasm surrounding a nucleus."[10]

Now the cell-wall ceases to occupy attention. Henceforth the contention is over the nucleus. Brücke attacked it in this same year and undertook to show that it has a very doubtful existence in the realm of cryptogamic botany, provided, as he naively remarks, we "do not start out with the belief that the nucleus is there even though we do not see it." The discovery of non-nucleated protozoa, soon after extended the same skepticism to the animal kingdom; and so the way was prepared for Beale's theory, which was then announced. Its basis was laid in some preliminary publications in 1860; but it was more formally expounded in 1861, in a series of lectures delivered at the Royal College of Physicians. Still later, it was further elaborated in ten lectures given at King's College.[11]

The substance of his theory, as set forth in these lectures, is that every living being, from the simplest to the highest and most complex, is composed partly of a semi-fluid, granular material and partly of more solid tissues; that the tissues are formed from the granular material; that the granular material is always within, the formed material on the outside of an elementary part; that the granular material alone is concerned in the operations of growth, nutrition, and development,—alone possess the power of selecting pabulum; that pabulum is worn-out tissue; and that therefore there are but two kinds of substances in every organism, namely, germinal matter and formed material:—the former always alive, the latter always dead.

He tells us that "the germinal matter which is formed in the nerves or muscles of any of the higher animals cannot be distinguished from the germinal matter in the tissues of the leaf of a plant, or from that which exists in the particles of the lowest

[10] "The Cell Doctrine." P. 80.

[11] "On the Structure and Growth of the Tissues, and on Life." London, 1865.

fungus," that germinal matter is met with in varying proportions in all living tissues, but that it is most abundant in those most actively growing, and that, in the earliest period of their existence, tissues are entirely composed of it. He claims to have shown "that every particle of matter exhibiting vital phenomena is derived, not from the formed material, but from pre-existing living or germinal matter, which exhibited similar phenomena, and so from the first creation." This living matter is always colourless, always contains much water, and is structureless and formless, although Doctor Beale says that it "consists of particles, which, when free, invariably become spherical," and that these spherules "are composed of spherules ad infinitum." Finally, he expresses the belief that, in the living state, "the elements of the matter and the forces associated with them are maintained in some remarkable and exceptional condition which is quite peculiar, to which no parallel whatever can be offered," and which he attributes "to the operation of *Vital Power*."

Doctor Beale's King's College lectures were greatly expanded in later years, and underwent changes of form and of name ; but I cannot see that much was really added to the substantial framework of his theory. A considerable weight of controversial matter, was, however, superimposed, and this proved, as might be expected, an element of weakness rather than of strength. But, although his later works did not actually enlarge the scope of his hypothesis, they afforded him opportunity to state more fully his views of some of the less essential details. Thus he was able to elaborate his conception of the wide separation between his two forms of organic substances, and to insist with more emphasis "that between the living state of matter and its non-living state there is an absolute and irreconcilable difference ; that, so far from our being able to demonstrate that the non-living passes by gradations into, or gradually assumes the state or condition of the living, the transition is sudden and abrupt ; and that matter already in the living state may pass into the non-living condition in the same sudden and complete manner ; that while in all living things chemical and physical actions occur, there are other actions, as essential as they are peculiar to life, which, so far from being of this nature, are opposed to, and are capable of overcoming, physical and

chemical attractions;" and, moreover, "that the non-living matter is the seat of the physical and chemical phenomena occurring in living beings, but that the vital actions occur in the living matter only."[12]

But, beside furnishing the occasion for greater particularity in the exposition of his theory of life, Doctor Beale's newer presentation of the general subject opened the way to interesting and somewhat novel ideas concerning death. He accordingly undertook to convince us that "all form, colour, structure, mechanism, observed at a later period in the life-history of living things, result from changes in this primary structureless, colourless material, * * * * which looks like mere jelly, or a little clear gum or syrup;" and that these changes—these transitions from formative to formed—are universally accompanied by a cessation of life. They are the converse of the process by which dead pabulum becomes living protoplasm, and all vital action on one side and all organic form on the other result from the swing of the pendulum to and fro,—the down beat being no less important than the up beat. According to his conception "all bioplasm must die. By its death marvellous things are produced and wonderful acts are performed. Every form in nature,—leaves, flowers, trees, shells; every tissue,—hair, skin, bone, nerve, muscle,—results from the death of bioplasm. * * * * Once dead, bioplasm ceases to be bioplasm and is resolved into other things; but these things that are *formed* cannot be put together again to reform the bioplasm. They may be taken up by new bioplasm, and so converted into living matter; but the bioplasm that existed once can never exist again."

Concerning the origin of bioplasm, Doctor Beale offers no very distinctive belief. He says, however, that "whether one primitive mass of bioplasm was caused to be, in the first creation, or five, or fifty, or whether thousands or millions, rushed simultaneously or successively into being, is open to discussion; but the arguments in favour of the view that a minute mass of structureless bioplasm was the first form of living thing are so overwhelming that they must carry conviction."

A few years before these passages were written, Doctor Beale had first proposed, as an exclusive name for the "living or self-

[12] "Bioplasm; an Introduction to the Study of Physiology and Medicine." London, 1872.

increasing matter of living beings," this word *bioplasm*, and in support of its application had urged that "now that the word biology has come into common use, it seems desirable to employ the same root in designating the matter which it is the main purpose of biology to investigate "[13] The word *protoplasm* had been associated with too many different substances to suit Doctor Beale's object which was to indicate matter in its most unstable form, before it has become an organ, a structure, a tissue, a cell ;—while it is merely formative but still unformed. The older word, as Doctor Drysdale remarks, had "been used in a loose way and applied to objects which have no title to vitality," and, as the term *germinal matter* had, for some reason, been thought inconvenient, Doctor Beale sought to create a name which should mean simply and solely *living plastic matter*, or, as Huxley afterwards called it, *life-stuff.* But *protoplasm* could not be dispossessed and, though *bioplasm* is probably the better word, the older name descended by inheritance to the new idea, and even Beale himself accepted and used it in his later works.

In fact, there may be very good reason for this supremacy of the original designation if, as Doctor Drysdale asserts, "the living matter of Beale corresponds to the following histological elements of other authors : the viscid nitrogenous substance within the primordial utricle, called by von Mohl, protoplasm ; the primordial utricle itself in Naegeli's sense of that term, viz., the layer of protoplasm next the cell-wall ; the transparent, semifluid matter occupying the spaces and intervals between the threads and walls of those spaces formed by the so-called vacuolation of protoplasmic masses ; the greater part of the sarcode of the monera, rhizopoda, and other low organisms ; the white blood-corpuscles, pus-corpuscles, and other naked wandering masses of living matter ; the so-called nucleus of the secreting cells, and of the tissues of the higher animals, and many plant-cells ; the nuclei of the cells of the grey matter of the brain, spinal marrow, and ganglions, and the nuclei of nerve-fibres."

Doctor Beale himself puts the case quite as strongly in his latest work on this general topic, in which he says : "if certain authorities were asked to define exactly the characters of the matter which they called protoplasm, we should have from those

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[13] Quart. Jour. Mic. Sci. July, 1870.

authors definitions applying to things essentially different from one another. Hard and soft, solid and liquid, coloured and colourless, opaque and transparent, granular and destitute of granules, structureless and having structure, moving and incapable of movement, active and passive, contractile and non-contractile, growing and incapable of growth, changing and incapable of change, animate and inanimate, alive and dead,—are some of the opposite qualities possessed by different kinds of matter which have nevertheless been called protoplasm."[14]

Notwithstanding the justness of this criticism of the general looseness of other authors, there is some ground for thinking that Doctor Beale has not been entirely clear and consistent in his description and identification of his own germinal matter; for, although he declares that "bioplasm or living matter is always transparent, colourless, and, as far as can be ascertained by examination with the highest powers, *perfectly structureless*," he afterwards speaks of the substance of the amoeba as being "darker and more granular in some places than in others;" he distinctly admits that "the bioplasm of all organisms, and of the tissues and organs of each organism, exhibits precisely the same characters;" and he still later refers to the "component particles" of bioplasm, which he finally distinguishes as bioplasts. The ovum, he tells us, "at an early period of its development is but a naked mass of bioplasm, without any cell-walls, but having a new centre or many new centres (known as germinal spots or nuclei) embedded in it." These germinal spots "are in fact new living centres of growth," and we may perhaps be excused for asking whether the existence of so great differences of function in different parts of the bioplasm of the amoeba, the white blood-corpuscle, the Vallisneria bioplasm, the mucus corpuscle, and the ovum, are not pretty strong indications of structure. The question is therefore whether these things are, after all, composed entirely of bioplasm; for Doctor Drysdale lays down the rule that "the name of bioplasm, given by Beale, or protoplasm (in a restricted sense, as it will probably be ultimately accepted by biologists), as indicating the *ideal* living matter, cannot be given to any substance displaying rigidity in any degree, from the softest gelatinous membrane up

[14] "Protoplasm: or Matter and Life." 1874.

to the hardest teeth-enamel; nor to anything exhibiting a trace of structure to the finest microscope; nor to any liquid; nor to any substance capable of true solution."[15]

It is plain from all that has been said that Beale's theory dispenses with the cell-wall as an essential part of the ultimate physiological unit, and that under his system the nucleus becomes a mere centre of activity:—the spot where vitality bubbles up and overflows to the adjacent protoplasm. The mystery of life is therefore narrowed to a veritable point within a simple habitat; and, in the words of Doctor Drysdale, the problem which Doctor Beale had undertaken was "to account for all the vital phenomena of a complicated individual of the higher orders by the sole action of this structureless, clear, semi-fluid matter."

But now Professor Huxley takes in hand the broader task which Cohn had begun twenty years earlier, in an endeavor to prove that "there is some one kind of matter which is common to all living beings, and that their endless diversities are bound together by a physical, as well as an ideal, unity." This is the primary thesis of his lecture on "The Physical Basis of Life,"[16] or, as he at first entitled it, "The Bases of Physical Life."[17]

Now Doctor Beale has said that, although all bioplasm possesses certain common characters, "we must admit that in nature there are different kinds of bioplasm indistinguishable by physics and chemistry, but endowed with different powers, flourishing under different circumstances, consuming different kinds of pabulum, growing at a different rate and under very different conditions as regards temperature, moisture, light, and atmosphere, possessing different degrees of resisting power, and dying under very different circumstances, having varying powers of resisting alterations in external conditions." Doctor Beale's bioplasm is therefore an "ideal" living matter, of a generic similarity rather than of a specific identity.

Although the general purpose of Professor Huxley's essay is to show that all protoplasms are one, or that they are mutually convertible into one another, he is obliged, at the outset, to

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15 "The Protoplasmic Theory of Life." P. 45.

16 Fortnightly Review. Feby. 1, 1869.

17 The Scotsman. Nov. 9, 1868.

make an admission somewhat in the line of Doctor Beale's distinction between bioplasms "consuming different kinds of pabulum;" for he is so frank as to say that "notwithstanding all the fundamental resemblances which exist between the powers of the protoplasm in plants and in animals, they present a striking difference * * * * in the fact that plants can manufacture fresh protoplasm out of mineral compounds, whereas animals are obliged to procure it ready made, and hence, in the long run, depend upon plants." While his imaginative eye is able to see a "community of faculty * * * * between the brightly-coloured lichen, which so nearly resembles a mere mineral incrustation of the bare rock on which it grows, and the painter to whom it is instinct with beauty, or the botanist, whom it feeds with knowledge," or to discern a hidden bond connecting "the flower which a girl wears in her hair, and the blood which courses through her youthful veins;" he nevertheless stops to have it "understood that this general uniformity by no means excludes any amount of special modifications of the fundamental substance." Still, in the protoplasm of the microscopic alga or fungus, and that of the leaf-cell or leaf-hair; in the substance of the organless and almost formless moner or amoeba, and that of the ever-changing white blood-corpuscle of a whale or of a man; in the matter of the nucleated epithelial cell, and that of the animal ovum; he beholds "the clay of the potter; which, bake it and paint it as you will, remains clay, separated by artifice and not by nature, from the commonest brick or sun-dried clod." "Thus," he concludes, "it becomes clear that all living powers are cognate, and that all living forms are fundamentally of one character."

Then he goes on to say, "the researches of the chemist have revealed a no less striking uniformity of material composition in living matter. In perfect strictness it is true that chemical investigation can tell us little or nothing, directly, of the composition of living matter, inasmuch as such matter must needs die in the act of analysis." One fact, however, remains out of reach of the refinements of logic which objectors have raised upon this point: "and this is that all the forms of protoplasm which have yet been examined contain the four elements, carbon, hydrogen, oxygen, and nitrogen, in very complex union and that they behave similarly towards several reagents."

As to the bearing of all this upon the cell-doctrine, Professor Huxley gives it as his opinion that "a nucleated mass of protoplasm turns out to be what may be termed the structural unit of the human body. As a matter of fact, the body in its earliest state, is a mere multiple of such units; and, in its perfect condition, it is a multiple of such units variously modified." "But," asks Professor Huxley, "does the formula which expresses the essential structural character of the highest animal cover all the rest, as the statement of its powers and faculties covered that of all others?" And his reply is: "Very nearly. Beast and fowl, reptile and fish, mollusk, worm, and polype, are all composed of structural units of the same character, namely masses of protoplasm with a nucleus. There are sundry very low animals, each of which, structurally, is a mere colourless blood-corpuscle leading an independent life. But at the very bottom of the animal scale even this simplicity becomes simplified, and all the phenomena of life are manifested by a particle of protoplasm without a nucleus."

It ought, however, to be pointed out here, as it was long ago by certain writers, that, notwithstanding the similarity in form between a moner and a white blood corpuscle, the corpuscles of a whale spilled in the sea would not continue their existence as monera, nor would monera injected into the veins of one of the higher animals perform the offices of the blood-corpuscles.

At any rate, it is very evident that Professor Huxley is one of those who have discarded the cell-wall as an essential part of the structural unit, though it is not quite certain that he is ready wholly to relinquish the nucleus. Still, his theory, like Beale's, calls for a formative *matter*, rather than a forming *vesicle*, as the foundation of every living structure, and the cell-wall, when there is any, becomes a result of what then becomes cell-contents:—the latter being cause to the former as effect, just as the test is the product of the enclosed foraminifer, or the shell of the mollusk.

Having settled upon a mere mass of living matter as the structural unit, Professor Huxley inquires "now what is the ultimate fate and what the origin of the matter of life? Is it, as some of the older naturalists supposed, diffused throughout the universe in molecules which are indestructible, and unchangeable in themselves; but, in endless transmigration, unite in

innumerable permutations, into the diversified forms of life we know? Or is the matter of life composed of ordinary matter, differing from it only in the manner in which its atoms are aggregated? Is it built up of ordinary matter, and again resolved into ordinary matter when its work is done?" To these queries Professor Huxley, in the name of modern science, answers, as Doctor Beale would answer, that "under whatever disguise it takes refuge, whether fungus or oak, worm or man, the living protoplasm not only ultimately dies and is resolved into its mineral and lifeless constituents, but is always dying, and, strange as the paradox may sound, could not live unless it died." "All work," he goes on to say, "implies waste, and the work of life results, directly or indirectly, in the waste of protoplasm." But "it is clear that this process of expenditure cannot go on forever," and so the problem is reached: how is the renewal of protoplasm accomplished? Here again Professor Huxley answers as Doctor Beale would answer:—by the appropriation and assimilation of pabulum; but as to the nature and properties of pabulum, he and Doctor Beale differ absolutely.

To Doctor Beale there is as much difference between living protoplasm and dead pabulum as there is between the ox and his hay. To him living protoplasm alone is protoplasm. No such thing as dead protoplasm is possible. Protoplasm invariably dies into formed material, and formed material may become pabulum. Pabulum does, indeed, again become protoplasm; but the three things I have named are always perfectly distinct, at least there is an absolute gulf between protoplasm and pabulum; and when pabulum becomes protoplasm it is by a sudden, less than instantaneous, leap, and not by a graded progression.

But to Professor Huxley, the mutton, lobster, or bread which he supposes himself to take for the replenishment of his wasted protoplasm, appears to be itself protoplasm, though he speaks of it as dead for the time being, and as if its life-history (whether in biped, quadruped, crustacean, or cereal) depended merely upon the channel into which it chanced to drift, and the motion it happened to acquire, as it was borne along the general stream of organic existence; for he says: "this mutton was once the living protoplasm, more or less modified, of another animal,—a sheep. As I shall eat it, it is the same matter altered, not only by death, but by exposure to sundry artificial operations in the

process of cooking. But these changes, whatever be their extent, have not rendered it incompetent to resume its old functions as matter of life. A singular inward laboratory, which I possess, will dissolve a certain portion of the modified protoplasm, the solution so formed will pass into my veins; and the subtle influences to which it will then be subjected will convert the *dead protoplasm* into *living protoplasm* and transubstantiate sheep into man. Nor is this all. If digestion were a thing to be trifled with, I might sup upon lobster, and the matter of life of the crustacean would undergo the same wonderful metamorphosis into humanity. And were I to return to my own place by sea, and undergo shipwreck, the crustacea might, and probably would, return the compliment, and demonstrate our common nature, by turning my protoplasm into living lobster. Or, if nothing better were to be had, I might supply my wants with mere bread, and I should find the protoplasm of the wheat-plant to be convertible into man, with no more trouble than that of the sheep, and with far less, I fancy, than that of the lobster. Hence it appears to be a matter of no great moment what animal, or what plant, I lay under contribution for protoplasm, and the fact speaks volumes for the general identity of that substance in all living beings. I share this catholicity of assimilation with other animals, all of which, so far as we know, could thrive equally well on the protoplasm of any of their fellows, or of any plant."

This argument was taken up and commented upon somewhat satirically and, as I think, in the main, reasonably, by Doctor Sterling, who has said, with reference to it, "Is it true that every organism can digest every other organism, and that thus a relation of identity is established between that which digests and whatever is digested? * * * * It is very evident that there is an end of the argument if all foods and all feeders are essentially identical both with themselves and with each other. * * * * It is not long since Mr. Huxley himself pointed out the great difference between the foods of plants and the foods of animals. * * * * Mr. Huxley talks feelingly of the possibility of himself feeding the lobster quite as much as of the lobster feeding him; but such pathos is not always applicable; it is not likely that a sponge would be to the stomach of Mr. Huxley any more than Mr. Huxley to the stomach of a sponge.

* * * * We can neither acquire the functions of what we eat, nor impart our functions to what eats us. We shall not come to fly by feeding on vultures, nor they to speak by feeding on us. No possible manure of human brains will enable a corn-field to reason." [18]

On the subject of chemical constitution Professor Huxley says "it will be observed that the existence of the matter of life depends on the pre-existence of certain compounds, namely, carbonic acid, water and ammonia. Withdraw any one of these three from the world and all vital phenomena come to an end. They are related to the protoplasm of the plant, as the protoplasm of the plant is to that of the animal. Carbon, hydrogen, oxygen, and nitrogen are all lifeless bodies. Of these carbon and oxygen unite in certain proportions and under certain conditions, to give rise to carbonic acid; hydrogen and oxygen produce water; nitrogen and hydrogen give rise to ammonia. These new compounds, like the elementary bodies of which they are composed, are lifeless. But when they are brought together under certain conditions they give rise to the still more complex body, protoplasm, and this protoplasm exhibits the phenomena of life. I see no break in this series of steps in molecular complication, and I am unable to understand why the language which is applicable to any one term of the series may not be used to any of the others;" and so he at last comes to ask: "What better philosophical status has *vitality* than *aquosity?*" To which Doctor Sterling replies: "The molecules are as fully accounted for in protoplasm as in water; but the sum of qualities thus exhausted in the latter, is not so exhausted in the former, in which there are qualities due, plainly, not to the molecules as molecules, but to the form into which they are thrown, and the force that makes that form one. * * * * As the differences of ice and steam from water lay not in the hydrogen and oxygen, but in the heat, so the difference of living from dead protoplasm lies not in the carbon, the hydrogen, the oxygen, and the nitrogen, but in the vital organization. In all cases, for the new quality, plainly, we must have a new explanation. The qualities of a steam-engine are not the results of its simple chemistry."

[18] "As Regards Protoplasm." By James Hutchison Sterling, LL. D. Edinburgh, Oct. 1869, 2d edn., 1872.

Whatever we may think of this discussion, we must perceive that, by this time, the cell doctrine had been wholly lost sight of, and that the protoplasm theory had occupied the entire field, although Doctor Beale was still feebly expressing the hope "that the short convenient word *cell* should not be discarded," and was venturing to "think that the phenomena essential to living matter are only possible in minute masses separated from one another, so that each may be supplied upon its circumference with nutrient materials." But it had become a general tendency to make life an attribute of a *substance* as distinguished from a *form*. As Doctor Sterling said with reference to Professor Huxley, the thing aimed at, as a result of mere ordinary chemical process, was "a life-stuff in mass, as it were in the web, to which he has only to resort for cuttings and cuttings in order to produce, by aggregation, what organized individual he pleases;" or, as he describes it more briefly, protoplasm by the spoonful or toothpickful.

Now this basal matter of life, which was thus to be taken by the spoonful or toothpickful to make a living organism, was at this time, by common consent, looked upon as a homogeneous, structureless substance, not distinguishable in merely physical constitution from other members of the class proteids;—a veritable colloid, differing from other colloids only in the respect of being as ceaselessly active as they are continually passive. Very soon, however, even this doctrine of homogeneousness and structurelessness was attacked; for, as it would seem we might have anticipated, increasing microscopical powers and improving methods of observation began to disclose to some investigators first differences of function in different portions of the heretofore seemingly undifferentiated protoplasm of the lower organisms, and then an actual structure which narrowed the basis of life to a fine net-work within what before had been regarded as a wholly living substance.

This condition of things had not been suspected by Professor Huxley and others who believed that protoplasm as they saw it in the nettle-sting and in the white blood-corpuscle was absolutely the starting-point of structural evolution;—a simple formative, but formless, matter. They were compelled, however, to recognize the fact that one bit of apparently homogeneous living jelly was bound to follow a life-history entirely dis-

tinct from that of another bit of living jelly optically exactly like it; and that the one never would fulfill by accident, and never could be made to fulfill, the destiny of the other. But this difference of function and behavior in forms merely looking alike, they undertook to account for either by purely chemical symbolism, as we have seen Professor Huxley doing, or else by arguments from the laws of molecular physics. Thus Professor Rutherford, at the British Association meeting in 1873, said: "There appears to be no reason for supposing that two particles of protoplasm, which possess a similar microscopic structure, must act in the same way; for the physicist knows that molecular structure and action are beyond the ken of the microscopist, and that within apparently homogeneous jelly-like particles of protoplasm there may be differences of molecular constitution and arrangement which determine widely different properties." Hæckel also had said: "All the immeasurable variety in the most diverse properties of organic bodies perceptible to the senses, which excite and delight our perceptions, is to be traced back to the alike infinitely numerous and delicate differences in the atomic constitution of the albumen-compounds which constitute the plasma of the plastids."[19]

The trouble with these arguments is that they assume that investigation into the composition of protoplasm had really got down as deep as molecular structure. The fact is that the occasion had not yet arisen for a final refuge in what Professor Tyndall has aptly termed "the scientific use of the imagination;" for it was soon proven that the resources of instrumentally-aided eye-sight had been by no means exhausted. Purely optical methods began to develop a necessity for a distinction of parts in what had been regarded as homogeneous, and the introduction of the words "cytoplasma," "hyaloplasma," "polioplasma," "paraplasma," etc., into the nomenclature of the subject, testified to the differentiation which was coming to light.

Professor Goodale has set forth very clearly the changes which have taken place in the botanical phase of this subject during the last twenty years, in his presidential address to the biological section of the American Association, at its recent Toronto meeting. He shows that at the beginning of this period "the following points were regarded as established: 1. All of

[19] "Generale Morphologie."

the activities of the vegetable cell are manifested in its protoplasmic contents ; 2. Protoplasm consists chemically of a nitrogenous basis ; 3. Protoplasm has no demonstrable structure ; 4. The protoplasmic contents in one vegetable cell are not connected with the protoplasmic contents in adjoining cells ; 5. The nucleus and other vitalized granules in the vegetable cell are formed by differentiation from amorphous protoplasm ;" and that, while the first proposition may be considered as finally established, the conception of the second has been considerably modified, and all the others have been completely disproved. He says, further, that "instead of regarding the protoplasmic basis as comparatively simple, it is now known to be exceedingly complex, and to contain numerous cognate proteids, some of which can be identified in the basic mass, others in the nucleus, and others still in the vitalized granules ;" and that the results of various studies "compel us to recognize in protoplasm a substance of bewildering complexity of composition and constitution."

This fact began to be apparent in the animal realm when Heitzmann, Klein and others announced the discovery of an "intra-cellular net-work" in the white blood-corpuscle, the points of intersection of the reticulum being what had been previously called the granules. In a paper read before our New York Academy of Sciences in 1879,[20] Doctor Elsberg called attention to the communication to the Vienna Academy, in 1873, in which Doctor Heitzmann "demonstrated the existence of a net-work in amœbæ, blood-corpuscles of astacus and of triton, human colorless blood-corpuscles and colostrum corpuscles ; and, from direct observation of the changes in the reticulum during the contraction of the living body, announced that the substance constituting the net-work is itself the living matter or bioplasm ;" and Doctor Elsberg himself endeavored to demonstrate a similar structure in the red blood-corpuscles.

I can well remember, as perhaps you also can, the disgusted incredulity with which this new doctrine was received,—an incredulity in which, I confess, I then shared I am not sure that the appearance of a reticulum in the prepared blood-corpuscle is even yet generally accepted as evidence of a normal structure of the kind claimed by Doctor Heitzmann ; but the claim cer-

[20] "The Structure of Colored Blood-Corpuscles." Annals N. Y. Acad. Sci. Vol. I.

tainly gains support from the fact that vegetable histologists are pretty well agreed that a more or less similar reticulum is demonstrable in the protoplasm of plants. Professor Goodale seems to have no doubt on this point, although he thinks that "this conception of protoplasm as a mass composed of a net-work of minutest fibres enclosing in the meshes another substance, presents * * * * great difficulties when we endeavor to explain the movements within the cell;" and that "it is very difficult to explain in any way the so-called wandering of protoplasm outside the cell-wall or into intercellular spaces."

Doctor Heitzmann, however, considers the reticulum or mesh an easy explanation of protoplasmic movements. To him the net-work of living, contractile matter contains in its interstices a lifeless liquid, which, by its contraction, it is able to squeeze out of itself, or from one part to another. Thus, he says, "the liquid held in the meshes, being driven out of the contracted portion will rush into a portion at the time at rest, and will extend this portion in the shape of what has been termed pseudopodia."[21]

In the work from which I have just quoted, Doctor Heitzmann generalizes as follows: "What * * * * was called a structureless, elementary organism, a 'cell,' I have demonstrated to consist only in part of living matter, while even the minutest granules of this matter are endowed with manifestations of life. The cell of the authors, therefore, is not an elementary, but a rather complicated, organism, of which small detached portions will exhibit amœboid motions. * * * * How complicated the structure of a minute particle of living matter may be, we can hardly imagine; what we do know is that the so-called 'cell' is composed of innumerable particles of living matter, every one of which is endowed with properties formerly attributed to the cell-organism."

It having been shown that life hangs upon a web of infinite tenuity, and does not reside necessarily in either a vesicle or a lump, it was a natural and easy step to extend this net-work from tissue to tissue and organ to organ, in an unbroken circuit of vital communication. This step Doctor Heitzmann does not hesitate to take; for, says he, "there is no such thing as an isolated, individual cell in the tissues, as all cells prove to be joined

21 "Microscopical Morphology." New York, 1883.

throughout the organism, thus rendering the body *in toto* an individual. What was formerly thought to be a cell is, in the present view, a node of a reticulum traversing the tissue. * * * * The living matter of the tissues exists mainly in the reticular stage, and is interconnected without interruption throughout the body."

Again this at first very strange and, for some reason or another, unwelcome doctrine receives support from the investigations of botanists ; for, as Professor Goodale remarks, this protoplasmic intercommunication between adjoining cells "has been shown to be so widely true in the case of the plants hitherto investigated, that the generalization has been ventured on that all the protoplasm throughout the plant is continuous." The position to which we have traced this matter is, then, that to the latest biology, in any particular organism, a generally diffused and interconnected substance, simple only in appearance under present optical aids, has taken the place of the circumscribed, more or less isolated and independent, and recognizably complex vesicle which was the physical basis of life to the science of fifty years ago. In the words of Doctor Heitzmann, "according to the former view, the body is composed of colonies of amœbæ : according to the latter, the body is composed of one complex amœba."

Here we must pause to note briefly what effect this abolition of the cell-doctrine has had upon the conception of vitality. I said at the beginning of my address that the protoplasmic theory of life might be traced up-stream to a revolt against the belief in a vital principle received into the organism as a whole,—not evolved by its organs or parts. In other words, the newer tendency was supposed to be distinctly materialistic, as against the older faith which was plainly spiritualistic. According to the earlier conception, every man was a doubly-refracted image,—a bodily person overlying a spiritual person,—the one co-extensive with the other. Substantially the same idea was extended to the lower animals and to plants ; whatever the vitalizing essence was, it was a whole, as the animal or the plant was a whole. The manifestation of life in an organism was not looked upon as an aggregate of the vital actions of minor parts, emanating and radiating from them, but as a pervading principle received into the parts, through the whole from without, as a

sponge absorbs water and sucks it into every cavity. Life, in short, was regarded as centripetal, not centrifugal ; and there was thought to be Scripture warrant for this view, in the record of the fact that the Creator, after fashioning the human form from purely inert material, at last breathed into it the breath of life and raised it up a sentient being.

But the tendency of the cell-doctrine was to disintegrate the vital principle,—to drive it into minute and independent centres, —to destroy the long-accepted idea of individuality. In place of one body containing one living spirit, a new conception was introduced, as we have seen, of an infinitely multiple body composed of absolute, though very minute, units, each possessing in itself all the essentials to vitality,—each inhabited by its own little vital spirit.

Now, when Beale announced his discovery of the seat of all vital action in a mere life-manifesting substance, without cell-wall or nucleus, and even, as he imagined, without structure, which substance was contained within every living tissue throughout the organism, he was supposed to have aimed a fatal blow at the materialistic conception of life. But we have observed how Professor Huxley, starting with Beale's ideal living matter, turned the argument again into the materialistic channel and undertook to prove, from Beale's premises, a conclusion in favor of mere chemistry and physics as against Beale's provisional "vital power." We have seen, too, how he shaped his argument to the thesis "all flesh is grass," or, as perhaps he would prefer to say, all flesh is clay, and the whole world is one great laboratory, and its sole shaping and directing powers are the physical and chemical forces ;—men are not different from other animals except in position ; all are but machines and their actions are automatic, originating in the functions not of separate cells, to be sure, but of separate masses, manifesting, in different ways, after all, only modes of one motion, namely, contractility.

Then came the men who dissected and analyzed Huxley's physical basis of life and showed that its bulk and substance is in truth as lifeless as the water in the sponge ; who replaced his life in masses or lumps by what Doctor Sterling had already unwittingly designated as "life in the web." And so we have arrived at a point in our historical survey at which life is supposed literally to hang upon a slender thread, intact throughout,

though infinitely extended and interwoven through the whole organism. Upon this warp the ancient figure of a vital spirit may easily be rewrought ; once more the way is prepared for a re-entrance of the spiritualistic conception of life. The breath of speculation has thus blown upon the surface of truth, and we have seen wave after wave roll by, each in its turn filling the field of vision and obscuring the level horizon beyond. But one wave cannot be more permanent than another, and the last we have looked upon is not in fact the last.

While the protoplasm theory has been assuming the form just mentioned, the cell doctrine also has been taking on an entirely new aspect. The door has suddenly been opened to a whole world of hitherto unknown non-nucleated organisms whose study is now engrossing the attention and monopolizing the energies of investigators everywhere. Bacteriology is the key to present biology. Strangely enough, too, we are once more eagerly searching for a solution of the problem of life through a close scrutiny of the phenomena of death ; for these new organisms, which are found to swarm in unimaginable plenitude, seem to be the counterbalance on the forces of vitality. "Mildew, mould, bacteria, * * * * monads, two thousand of which would go to make up a millimeter, all these microscopic organisms are charged with the great work of re-establishing the equilibrium of life by giving back to it all that it has formed." [22]

To Louis Pasteur belongs the credit for a large part of the labor of investigating the offices and actions of these micro-organisms, or microbes, in the processes of disorganization and dissolution. To him belongs the whole of the credit for reducing these processes to a single genus or type. He first explained to us the *modus operandi* of the formerly mysterious operations of death, decay and putrefaction, with their accompanying and complementary phenomena of resuscitation, nutrition, and reproduction. As M. Radot says, in summing up Professor Pasteur's conclusions on this subject, "All that has lived must die, and all that is dead must be disintegrated, dissolved or gasified ; the elements which are the substratum of life must enter into new cycles of life. If things were otherwise the matter of organized beings would encumber the surface of the earth, and the law of

[22] "Louis Pasteur, His Life and Labors." By his Son-in-law (M. Radot).

the perpetuity of life would be compromised by the gradual exhaustion of its materials. One grand phenomenon presides over this vast work, the phenomenon of fermentation." It was Pasteur who first clearly demonstrated that fermentation is always dependent on the life of a microscopic organism : that in fact it is "simply a phenomenon of nutrition." As Professor Tyndall says, in his introduction to the work from which I have just quoted : "with true scientific instinct, he closed with the conception that ferments are, in all cases, living things, and that the substances formerly regarded as ferments are, in reality, the food of the ferments ;" or, in the words of M. Radot, "the organism eats one part of the fermentable matter." Here, then, we have two of Beale's physiological elements, a speck of bioplasm and pabulum, translated into a uni-cellular ferment and its fermentable habitat.

Now, side by side with the new philosophy of fermentation there has developed a revolutionary idea in pathology, which has come to be known as the germ theory of disease. At first this theory was, as usual, pushed to an untenable extreme, in an assertion that all diseases were immediately caused by microbes which were introduced into the system from without and which produced their effects by a direct attack upon the tissues in which they lodged. As a result of the new philosophy of fermentation, however, it was soon found that microbes, acting as ferments, produced, by their action upon fermentable substances, peculiar chemical compounds, resembling the vegetable alkaloids, and which are now called ptomaines. This discovery led to a pretty lively discussion as to whether the microbe or the ptomaine was the immediate cause of the disease which ensued upon the introduction of a microbe into a living body ; and not until a ptomaine had been separated from its associate microbe and, by inoculation, had been caused to produce the disease previously supposed to be dependent on the presence of the microbe itself, was it admitted that, in some cases at least, the microbe was only an indirect cause of the disease, and the ptomaine was the more immediate.

It then became apparent that there were still two quite distinct classes of diseases, the infectious, originating without, and the autogenous, originating within, the organism. Plainly the latter did not easily come under the germ theory. It was next dis-

covered that even in the healthy animal system alkaloids were being constantly compounded, which could not be clearly distinguished from the vegetable alkaloids, or ptomaines. For these the name leucomaines was invented. But, having found that ptomaines were always products of fermentation, it was a natural step to the assumption that leucomaines must be results of a like process; and good reasons quickly appeared for this generalization. Fermentation, during which ptomaines are produced, being a phenomenon of nutrition, as between a unicellular organism and its pabulum: the organism, the ferment, being introduced from without into the fermentable substance;—analogy easily led to the conclusion that the production of leucomaines is a phenomenon of nutrition as between the normal constituent element of the body—(whether the old-fashioned cell, or the new-fashioned protoplasmic reticulum),—and its nourishing fluid.

Professor Joseph LeConte has recently called attention to this latest tendency of the cell doctrine, on which subject he says: "We have seen that ptomaines are alkaloids of albuminoid decomposition generated in the presence and under the guidance of microbian life. Now there is going on continually in the animal body, as a strictly physiological process, albuminoid decomposition (wasting of the tissues) in the presence and under the guidance of cell life. This also, as might be expected, produces poisonous products * * * * If they are not also usually deadly to the animal body, it is only because they are continually being eliminated by appropriate organs."[23] And this elimination, we may well imagine, is a result of the operation of natural selection, which has not yet produced immunity against all ptomaines, as it has against most leucomaines.

As it is not my purpose to discuss the germ theory itself, I shall not follow this subject further. Sufficient has been said to indicate the direction in which the cell doctrine, or perhaps I should say the protoplasm theory, is once more moving.

I must therefore bring my already too lengthy sketch to an end although, before actually closing, I cannot refrain from summarizing some of the conclusions which seem to me to be justified by the historical survey which I have endeavored to make.

First, then, the original idea of the cell, as propounded by

[23] Letter to "Science," Nov. 8, 1889.

Schleiden and Schwann, has gradually faded away. Such cells as they actually saw, do, indeed, still exist ; but the cells they thought they saw have been deprived of all that were by them considered essentials. The attention of the defenders of the cell doctrine has been forced from cell-wall to nucleus, from nucleus to nucleolus, from nucleolus to plastids, from plastids to germinal points ; a mathematical reduction to mere position without dimension ;—a subjective conception, not an objective realization. Parenchyma cells in plants, and epithelial cells in animals, are no less constituent rooms in an organic building than they formerly were ; but to the later science they are not the fundamental, autonomous units they were to the earlier science. Fifty years ago such cells as these stood upon the horizon of biological insight. To-day our vision extends far beyond them. To-morrow it will doubtless reach to distant points now even unimagined. At any rate, it is safe to say that, in the present condition of science, we have no actual knowledge of an ultimate unit, either physical or physiological. Science, nevertheless, like the youth in search of the gold at the end of the rain-bow, is ever pressing forward to fancied finalities, only to find new starting-points for a continuation of the race.

Second, no one has ever really seen Doctor Beale's ideal living matter. What he saw and called bioplasm was simple enough, compared with Dujardin's sarcode ; but, like sarcode, his bioplasm has proved to be exceedingly complex. At this moment the idea embraced in his designation, *germinal matter*, is applicable, if to any actually visible thing, to a mere skeleton of his original bioplasm. Next year it may be applicable to only a small part of this attenuated reticulum ;—and so on *ad infinitum.*

Third, Huxley's physical basis of life is pushed ahead again into the realm of the imagination. There probably is a physical basis, but it is not the particular basis Professor Huxley had in view ; because the protoplasm of the nettle-sting, the protoplasm of the globergerina, and the protoplasm of the blood-corpuscle are clearly proven to be different protoplasms, chemically as well as physically and physiologically. Moreover, it is pretty certain that one protoplasm cannot be converted into another, except through the process of dying, becoming pabulum, being decomposed by fermentation, converted into new compounds and appropriated and assimilated ;—which is a somewhat compli-

cated and, withal, mysterious operation. Professor Huxley's easy transubstantiation of protoplasm known as boiled mutton into protoplasm known as human brain-tissue, is consequently a myth.

This leads me to say, *Fourth*, that there appears to be no one visible and tangible substance to which the name protoplasm is rigidly and exclusively applied. As soon as we withdraw it from a purely philosophical concept, we find it attached to almost every sort of crude material which can by any possibility enter into the composition of a living structure. The name is, in particular, applied to any and every substance of a proteinaceous nature. In fact, with some writers, protoplasm is pretty nearly synonymous with proteid. Botanists are specially inexact in this respect. Having appropriated the name albumen for a substance not at all albuminous, they now seem to have adopted protoplasm as a designation for materials anything but protoplasmic. Beale's protoplasm, you will remember, is homogeneous, and structureless, and always contains much water. Professor Geddes, however, speaks of the "comparatively solid, almost brittle, state of the quiescent protoplasm of some seeds;"[24] and Professor Goodale tells us that the protoplasm of many kinds of seeds and spores can preserve its vitality during exposure to dry air at a temperature above that of boiling water under which condition he admits that it would be thoroughly dessicated.[25] "The consistence of protoplasm," he says, "depends on the amount of water which it contains. Thus in dry seeds it is nearly as tough as horn, while in the same seeds during germination it becomes like softened gelatin."[26] In another place he speaks of "inactive, amorphous protoplasm, as it sometimes exists in certain cells, where it is simply a tough, shapeless mass."[27] Fancy Doctor Beale's germinal matter reduced to the consistency of horn, or even to that of softened gelatin!

But, *Fifth*, if in some seeds (the so-called vegetable ivory, for example,) the only vitalizable substance is a solid, brittle, tough and horny proteid, it looks as if we had struck an inexplicable puzzle in the sudden appearance of the semi-fluid plastic proto-

[24] Encyclopædia Britannica; article, Protoplasm.

[25] Gray's Physiological Botany, p. 205.

[26] Ibid, p. 28.

[27] Ibid, p. 44.

plasm when the embryo begins to grow. Doctor Sterling, as well as Doctor Beale, insisted that vitality was an inherent and inseparable attribute of real protoplasm, and that consequently there could not be such a thing as dead protoplasm. I doubt whether, under their definitions, there can be even a dormant protoplasm ; for, in truth, what is dormant life, which this implies ? Is it not in effect dead life ? That is to say, is it not the essential sign of life that it is not dormant ? Beale urges that there is no intermediate step between dead matter and living matter. Matter, he argues, is either wholly alive or wholly dead. Latent life, then, is at bottom only one of the philosophical figments of which we have already heard. Suspended animation may be possible in a complicated organism, but if we are to follow the philosophers down to a basal life-stuff, we cannot logically admit any factor into the problem but matter and life. In other words, the only admissible alternative is matter plus vitality or matter minus vitality.

This, then, brings us to the point to which my address of a year ago brought us,—to the impassable gulf between the not-living and the living. This is the perennial mystery of mysteries to whose brink every thorough scientist and every deep philospher sooner or later comes, but beyond whose thick darkness no human eye can see, and under whose appalling silence even the wisest man must stand dumb.

SYNOPSIS OF THE CRETACEOUS FORAMINIFERA OF NEW JERSEY.

PART I. REVIEW OF PREVIOUS INVESTIGATIONS.

BY ANTHONY WOODWARD.

(*Presented December 20th*, 1889.)

The embodiment of this paper is to bring together all the work that has been previously done, and the remarks that have been made on the Cretaceous Foraminifera of New Jersey, from 1833–1889, by giving a reproduction of such parts of the various interesting and valuable papers of Isaac Lea, Jacob Whitman Bailey, Samuel George Morton, Charles Lyell, William M. Gabb, Auguste Emanuel Reuss, Fielding Bradford Meek, Louis F. De Pourtales, Herr Hermann von Credner, Thomas Rupert Jones and William Kitchen Parker as are scattered through literature, not always accessible.

1833. ISAAC LEA. Contributions to Geology, 219, 220. Description of a new Genus of the Family *Spherulacea* of Blainville, from the Cretaceous deposit of Timber Creek, New Jersey.

GENUS PALMULA (nobis).

Description. Shell palmate, with angular striæ, which indicate the interior chambers ; aperture terminal.

Observations. Two specimens of the shell on which I propose to found this genus, were found by me, about four years since, in the Cretaceous deposit of Timber Creek, New Jersey. In its characters it approximates most closely to the genus *Saracenaria* of Defrance. Manuel de Malacologie, Blainville, 370. The oval form, the possession of a carina, and the absence of an aperture in that genus, prohibit our shell being placed with it. The *Palmula* also resembles the genus *Textularia* of the same author, and might, perhaps, with propriety be placed between these two genera.

P. sagittaria. Pl. vi., fig. 228.

The small figure is of the size of nature.

Description. Shell depressed, sagittate, rounded on the edges, with about six angular striæ, which indicate the interior chambers ; mouth terminal, oval, sublabiate, Diameter .05, Length .2, Breadth .1 of an inch.

Observations. The two specimens differ somewhat in outline, the larger one being more elliptical. In both the angular striæ become obsolete at the base, being most distinct on the superior part.

1841. J. W. Bailey. Fossil Foraminifera in the Green Sand of New Jersey. Amer. Journ. Sci. xli. 213, 214.

In a recent visit to the Cretaceous formation of New Jersey, he has brought to light the interesting fact that a large portion of the calcareous rock, defined by Prof. H. D. Rogers as the third formation of the upper secondary, is made up, at the localities where he examined it, of great quantities of microscopic shells, belonging to the Foraminifera of d'Orbigny, which order includes those multilocular shells, which compose a large part of the calcareous sands, etc., of Grignon and other localties, in the tertiary deposits of Europe. Since the minute multilocular shells above alluded to were discovered, Dr. Torrey and Prof. Bailey have together examined specimens of limestone from Claiborne, Alabama, and have found in them Foraminifera, of forms apparently identical with those occurring in New Jersey. None of this order, except the genus *Nummulite*, have heretofore been noticed in our green-sand formation.

1842. S. G. Morton. Description of some new species of Organic Remains of the Cretaceous Group of the United States. Journ. Acad. Nat. Sci., viii. 214, 215, pl. xi. fig. 5.

Genus Planularia.

P. cuneata. Pl. xi. fig. 5. Shell ovate, slightly angulated in the middle; one side slightly concave, with concentric lines, which are angular in the centre of the disk. Length three-tenths of an inch.

From the middle cretaceous strata of New Jersey, where it was found by Mr. Conrad.

No locality given.

1845. Charles Lyell. Notes on the Cretaceous Strata, of New Jersey and other parts of the United States bordering the Atlantic. Quart. Journ. Geol. Soc. Lond., i. 56, 57, 64.

In an excursion which I made in New Jersey, in September, 1841, in company with Mr. Conrad, we went first to Bristol, on the Delaware, next, by Bordentown, to New Egypt, and returned by Timber Creek, recrossing the Delaware at Camden.

In the upper or straw-colored limestones, I found on the banks of the Timber Creek, twelve miles southeast of Philadelphia, six species of corals. The same calcareous formation also abounds in Foraminifera, characteristic of the chalk, comprising, among others, the genera *Cristellaria*, *Rotalina* and *Nodosaria*.

I saw the formation in question, on the banks of Timber Creek, a stream which flows into the Delaware three miles below Philadelphia.

The principal locality is twelve miles southeast of Philadelphia, about a mile and a half south of the village of White Horse, Gloucester County, New Jersey.

Notice of the Foraminifera by Lyell. (Figures *Rotalina* and *Cristellaria*).

The above are figures of two genera of Foraminifera from the upper beds at Timber Creek, alluded to in the paper. I am not aware that any attention has hitherto been paid to the fossil foraminifera of American Cretaceous strata, to which I find no allusion in Dr. Morton's works. They are very abundant in the coralline rock of Timber Creek. Mr. Forbes has examined some of them for me, and these belong to the genera *Cristellaria*, *Rotalina* and *Nodosaria*. All these genera occur in the chalk of Europe. One of my American species of fossil *Cristellaria* is specifically identified by Mr. Forbes with *C. rotulata* of d'Orbigny, which occurs in England, France and Germany, ranging from the upper greensand to white chalk. It is another instance of species found most abundantly in Europe, recurring in American chalk. There are two other species of the same genus at Timber Creek, one of them very large. There are two species of *Nodosaria*. The *Rotalina*, which is very abundant, is closely allied to species of our chalk.

1845. CHAS. LYELL. Travels in North America, i. 64.

He found, in the upper, or straw-colored limestone, on the banks of the Timber Creek, twelve miles southeast of Philadelphia, six species of corals and several echinoderms, chiefly allied to upper cretaceous forms. The same calcareous stratum also abounds in Foraminifera, characteristic of the chalk, comprising, among others, the genera *Cristellaria*, *Rotalina* and *Nodosaria*.

1856. J. W. BAILEY. On the Origin of Greensand, and its formations in the Oceans of the present epoch. Proc. Bost. Soc. Nat. Hist., v. 365, 366.

The formation of the Greensand consists in a gradual green-colored, opal-like mass, which forms therein as a cast. It is a peculiar species of natural injection, and is often so perfect, that not only the large and coarse cells, but also the very finest canals of the cell-walls, and all their connecting tubes are thus petrified, and separately exhibited. By no artificial method can such fine and perfect injections be obtained.

He mentions among his observations, that the yellowish limestone of the cretacecus deposits of New Jersey occurring with *Teredo tibialis*, etc., at Mullica Hill, and near Mount Holly, is very rich in greensand casts of *Polythalamia* and of the tubuliform bodies above alluded to.

1860. W. M. GABB. Descriptions of New Species of American Tertiary and Cretaceous Fossils. Journ. Acad. Nat. Sci., ser. 2. iv. 402, 403, pl. lxix. figs. 40, 41.

I have recognized a number of species of foraminifera, in a marl from near Mullica Hill, N. J., of the same age as Timber Creek limestone (upper part of No. 5 of Meek and Hayden,) abounding in corals, the most common of which is *Eschara digitata*. The matrix is fortunately not so hard as that at Timber Creek, and both the corals and foraminifera are much better preserved. I shall not describe any at present, except the beautiful *Dentalina*, given below. I expect, however, at some not very

distant period to characterize them. I have not yet seen *Cristellaria rotula*, said by Lyell to occur at Timber Creek, although I have examined several hundred specimens.

DENTALINA, d'Orb.

D. pulchra. Pl. lxix, figs. 40, 41. Elongated, very slightly arcuate; cells large, more convex towards the large extremity; diameters of cells equal; surface marked by about ten heavy, longitudinal ribs; sutures obliterated; opening small, tubulate and inclined in the direction of the curve.

Dimensions. Length about .25 in., greatest diameter .03 in. Locality —Near Mullica Hill, N. J. My collection. Rare.

1861. A. E. REUSS. Die Foraminiferen des senonischen Grünsandes von New Jersey. Paläontologische Beiträge. Sitzungsberichte d. kais. Akad. d. Wissenschaft in. Wien., xliv. 334–342, pls. i–viii.

(Translation.)

The Foraminifera of the Cretaceous Greensands from New Jersey.

From the materials furnished me for examination, I have to thank Dr. Hörnes, Director of the Imperial Cabinet of Mineralogy at Vienna, Dr. Krantz of Bonn, and especially Prof. Ferd. Römer of Breslau. The specimens from the first two contained but few foraminifera; those from Prof. Römer were quite rich in the same. Unfortunntely, however, they were for the most part not well preserved and the more fragile forms were present only in fragments.

The following is a list of the species found. They all belong to the polymerous Foraminifera, and the few species which appear to me to be new, I have described and figured.

1. RHABDOIDEA, Schltz.

a) NODOSARIDEA (m.)

a) **Nodosaria,** d'Orb.

1. *N. polygona*, Rss. Zeitschr. d. deutsch. geolog. Gesellsch., 1855, 265, pl. vii. figs. 7, 8. Fragments, rare. They are very often found however, in the upper Cretaceous of Mecklenburg.

2. *N.* sp. with globular chambers, separated by deep sutures, which are covered with numerous fine longitudinal ridges. The first chamber is equal in size to the following one, and ends in a very short, central spine. I saw only a fragment in which the last chamber was wanting.

b) **Dentalina,** d'Orb.

1. *D. gracilis*, d'Orb. Mém. de la soc. géol. de France, iv. 1, 14, pl. i. fig. 5. Very rare elsewhere in the upper chalk formations down to the "Pläner." Very widely distributed.

2. *D. colligata*, N. sp. Pl. vii. fig. 4. Approaching many species of *Marginulina.* Little bent, obtuse below, with six to seven chambers,

the first small, rounded, and scarcely larger than the next, from which externally, it does not appear to be separated. The remaining chambers increase upward gradually in breadth, with unequal sides. The ventral side is somewhat more ventricose than the dorsal side, and is separated by very small and shallow oblique sutures. On the concave dorsal side, all the chambers are united, as it were, by a small, narrow, smooth, slightly elevated ridge, upon which the division of the chambers is scarcely visible. The first chamber shows a slight tendency to curve forward ; the last, which is very oblique, ends at the dorsal angle in a short thick spine. Very rare.

3. *D. Steenstrupi*, Rss. See page 326. Very rare.

4. *D. confluens*, N. sp. Pl. vii. fig. 5. The shell (Gehäuse), which may be 3 mm. long, is rather thick, slightly bent, sometimes compressed, and consists of seven chambers, in the first of which the boundaries are not to be made out from the external appearance. Only the last chambers, which are slightly higher than broad, are marked off by very shallow sutures. They decrease in size downwards, but slowly, the lower extremity however, diminishing abruptly to form the short spine, the latter being sometimes directed backwards. The chambers are covered with 16–20 very narrow abrupt, longitudinal ridges, these are often irregularly sinuous, and increase in number, from below upward, by the insertion of new ones, or, by bifurcation, they are separated by narrow deep furrows between them. The last, very oblique, chambers run out into a very short spine which almost points backward. Very rare.

b) Frondicularidea (m.)

Flabellina, d'Orb.

Fl. cordata, Rss. Sitzungsber. d. k. Akad. d. Wiss., xl. 216. Very rare.

2. CRISTELLARIDEA, Schltz.

Cristellaria, Lam.

a) **Marginulina**, d'Orb.

M. ensis, Rss. Die Verstein. der böhm. Kreideform., i. 29, pl. xii. fig. 13, pl. xiii. figs. 26 ,27. Very rare. Frequent, however, in the upper cretaceous of other countries down to the " Pläner." England, Westphalia, Bohemia, Galieia, etc. Sitzungsber. d. k. Akad. d. Wiss. in Wien., xl. 207.

b) **Cristellaria**, d'Orb.

1. *Cr. intermedia*, Rss. var. Die Verstein. der böhm Kreideform., i. 33, pl. xiii. figs. 57, 58, pl. viii. fig. 2. The American specimens differ from the Bohemian in forming a more distinct and larger spiral, and in having the last chambers separated by deeper sutures, while the limits of the first ones are not externally visible. Very rare.

2. *Cr. Baylei*. N. sp. Pl. vii. fig. 7. Diameter 0.77 mm. Shell circular, moderately compressed, lens-shaped, with a sharply, keeled dor-

sum. Nine narrow strongly arched chambers, with low, but well defined septa, which run together in a central, small, low, irregular umbilicate disk. Aperture oval, cut in deeply two-thirds of the way up, through the next to the last whorls, almost forked. margined on both sides by a narrow ridge. Very rare.

3. *Cr. rotulata*, Lam. sp. L. c. 326. Rare.

c) **Robulina**, d'Orb.

R. trachyomphala, Rss. Haidinger's gesamm. naturwiss. Abhdl. iv. 1, 34, pl. iii. fig. 12. Rare. More frequent in the mucronate marl of Nagorzani at Lemberg. Young individuals have only 5–6 chambers, and a very small indistinct umbilicate disk. Some specimens are slightly keeled at the back.

3. LITUOLIDEA (m.)

Haplophragmium, Rss.

1. *H.* sp. A nonionian form, with six arched chambers separated by deep sutures. Shell very rough with small, roundish nonionian aperture. Only one specimen.

4. ROTALIDEA, Schltz.

Rotalia, Lam.

1. *R. nitida*, Rss. Sitzungsber. d. k. Akad. d. Wiss. in Wien., xl. 222. Very rare. Elsewhere occurring in the "Mucronaten und Quadraten Schichten," and in the "Pläner."

2. *R. Micheliniana*, d'Orb. Mém. de la. Soc. géol de Fr., iv. 1, 31, figs. 1–3. Very rare to the "Pläner." Also occurring in the upper Cretaceous of other countries down.

3. *R. polyraphes*, Rss. Haidinger's gesamm. naturwiss. Abhdl., iv. 1, 35, pl. iv. fig. 1. Very rare. Common in the mucronate and quadrate layers, and in the "Pläner" of other countries, rare in the Cretaceous and in the Gault. Numerous localities are mentioned in the Sitzungsber. d. k. Akad. d. Wiss. in Wien., xi. 77.

4. *R. Mortoni*, n. sp. Pl. viii. fig. 1. Common. Similar to *R. polyraphes*, Rss., and even more so to *R. lenticula*, Rss.—Die Kreideverstein. Böhmens, i. 35, pl. xii. fig. 17—but much larger than the last, more curved on the spiral side, with numerous and more narrow chambers. Diameter reaches 0.77 mm. The shell is depressed, lens-shaped, with an acute margin, both sides somewhat curved, the umbilicate side more strongly. On the spiral side usually only the last whorl is separated by a narrow but rather deep suture; the older two are but seldom distinguishable externally, and are covered by a calcareous incrustation, which is permeated by porous canals of varied sizes; nine to ten chambers in the last whorl, of which only the last two or three are separated by distinct sutures. They are only slightly curved. The others are usually indistinguishable externally. The umbilicate side shows in its centre either a very

narrow and shallow depression or none at all, or in place of it a small, flat disk-like elevation which is very finely porous. The chambers appear upon this surface as narrow triangles, somewhat curved, the sutures more distinct, as shallow lines. The porous canals, of the spiral side, are somewhat wider than the umbilical side. The aperture is a short opening situated far below the peripheric border.

5. *R. Karsteni*, Rss. Zeitschr. d. deutsch. geolog. Gesellsch., 1855, 273, pl. ix. fig. 6. Very rare.

Rosalina, d'Orb.

1. *R. ammonoides*, Rss. Reuss in Haidinger's gesamm. naturwiss. Abhdl., iv. 1, 36, pl. iv. fig. 2. Very rare. More frequent elsewhere in the upper chalk-beds, down to the Cretaceous.

2. *R. Bosqueti*, n. sp. L. c. 316, pl. iii. fig. 1. Very rare. Also in the chalk-tufa of Mastricht.

Truncatulina, d'Orb.

1. *Tr. convexa*, Rss. L. c. 331. Very rare. Is very variable, often bent and not always so arched as in the figure referred to on the above-mentioned page. Pl. iv. fig. 4.

2. *Tr. De Kayi*, n. sp. Pl. vii. fig. 6. Very rare. The shell which is only 0.49 mm. in diameter, is circular; the spiral side smooth, and only the last chamber slightly arched, with three whorls and a wrinkled upper surface. The umbilicate side arched, regular, with eight small curved chambers, of which only the last are marked off by distinct sutures. The surface coarsely punctate.

5. POLYMORPHINIDEA, d'Orb.

Bulimina, d'Orb.

1. *B. tortilis*, n. sp. Pl. viii. fig. 3. Frequent. A peculiar small species, at the most 0.52 mm. long, triangular pyramidal, with somewhat concave sides, and three longitudinal edges, which gradually become thicker and more obtuse from below upward, and which do not run directly up, but turn gradually in their course so that the whole shell seems twisted. Five whorls, the first ones very small, each consisting of three small semilunate curved chambers; the older ones externally, scarcely separable, slightly arched; the latter ones rapidly increasing in size, and becoming more strongly arched. The orifice, a short elliptical aperture, beginning immediately under the obtuse point of the last chamber, and running down toward the lateral surface of the shell.

2. *B.* sp. indet. Similar to *B. pupoides*, d'Orb.,—Foram. foss. du bass. tert. de Vienne, pl. ii. figs. 11, 12,—with an elongated, smooth irregular shell, with a roundish transverse section. Only one incomplete specimen.

Polymorphina, d'Orb.

a) Globulina, d'Orb.

1. *Gl. globosa*, v. Mstr. L. c. 318. Very rare.

2. *Gl. lacrima*, Rss. Haidinger's gesamm. naturwiss. Abhdl., iv. 1, 43, pl. v. fig. 9. Very rare, as in the mucronate marls of Lemberg.

b) Guttulina, d'Orb.

G. cretacea, Alth. L. c. 319. Very rare. A more slender, strongly pointed variety.

c) Polymorphina, d'Orb.

1. *P. subrhombica*, n. sp. Pl. vii. fig. 3. Very rare. The shell 0.98 mm. long, rhomboidal in outline, obtusely pointed to the same extent on both sides, the transverse section narrowly elliptical, the margins angular. There are to be seen externally only four slightly arched, double rows of alternating oblique chambers. Sutures linear, obscure, especially the lower ones. Orifice radiated. The species closely resembles *P. ovata*, d'Orb. Foraminifera du bass. tert. de Vienne, pl. xiii. figs. 1–3. From the miocene strata of the Vienna Basin, and with the oligocene.

2. *P. regularis*, v. M. Reuss, Sitzungsber. d. k. Akad. d. Wiss., xviii. 247, pl. vii. figs. 70–73. It is, however, sufficiently distinct from both.

From the preceding list it will be seen that I have thus far found 28 species of Foraminifera in the Cretaceous Greensand of New Jersey. From the many indeterminable fragments of which I could not possibly determine the genus, the number is undoubtedly greater. From the above number three species, which could not be positively decided on, must be omitted therefore, leaving only 25 species, of which 7—*Dentalina confluens*, *Dentalina colligata*, *Cristellaria Baylei*, *Rotalia Mortoni*, *Truncatulina De Kayi*, *Bulimina tortilis* and *Polymorphina subrhombica*—have, hitherto, not been discovered elsewhere. There remains for comparison only 18 species They are all collected in the upper Cretaceous of other countries, and 5 of them—*Robulina trachyomphala*, Rss., *Rosalina Bosqueti*, Rss., *Truncatulina convexa*, Rss., *Globulina lacrima*, Rss., and *Guttulina cretacea*, Alth.—are exclusive in these beds.

Four species—*Nodosaria polygona*, Rss., *Dentalina Steenstrupi*, Rss., *Cristellaria intermedia*, Rss., and *Rotalia Karsteni*, Rss.—are found in other countries in the Cretaceous beds also. Five species—*Dentalina gracilis*, d'Orb., *Rotalia nitida*, Rss., *Rotalia Micheliniana*, d'Orb., *Globulina globosa*, v. Mstr. and *Marginulina ensis*, Rss.—extend into the "Pläner." *Globulina globosa*, however, also extends upward into the Oligocene and Miocene Tertiary beds *Rosalina ammonoides* and *Fallina cordata*, Rss. extend from their vertical range and mucronate bed into the Cretaceous, while *Cristellaria rotulata*, Lam. sp. and *Rotalia polyraphes*, Rss. are found as low as the "Gault."

In the Cretaceous Greensand of New Jersey the Rhabdoidians and the Nodosaridians are represented by 6, the Frondiculariidians by 1, the Cristellaridians by 5 species, the Lituolidians by 1, the Rotalidians by 9, and finally the Polymorphinidians by 6 species. The Family of Rotalidians, therefore, furnishes the greatest number of species, while the Rhabdoidians and Polymorphinidians follow next in order. The most numerous species are those belonging to the genera *Rotalia* (5) and *Dentalina* (4). With

the exception of *Rotalia Mortoni* and *Bulimina tortilis* (both new species), of which numerous examples are found, the remainder appear seldom.

Most of them however are very rare. With the exception of the peculiarly formed *Bulimina tortilis*, all the remaining species offer nothing remarkable in their external appearance They belong to the ordinary, universally distributed, well-known types.

The reference in the description of *Cris. rotulata*: for which the reader is refered to p. 326, is as follows:

1. *Cr. rotulata*, Lam. sp, d'Orb. mém. de la Soc. géol. de France, iv. 1, 26, pl. ii. figs. 9, 15–18. This species, which is commonly distributed in the Cretaceous, occurs quite frequently, also in the chalk of Rügen, and in specimens of unusual size. The orifice is not stellate in any of the specimens at hand. In one, after often repeated and close examination, I could not discover any larger orifice.

I have mentioned numerous localities where this cosmopolitan species can be found, in my Monograph on the Foraminifera of Westphalian chalk formation. Sitzungsber. d. k. Akad. d. Wiss. in Wien., xl. 70.

The description of *R. Bosqueti*. on p. 316, is as follows:

2. *R. Bosqueti*, n. sp. Pl. iii. figs. 9, 1. Rare. Differing from the ordinary *Rosalina* type, more like many Rotalidæ with flat oval shells 0.7 mm. long, broadly oval, strongly depressed, rounded angular edges, very moderately arched spiral side, and somewhat pressed in umbilicate surface. The spiral side shows but two whorls, of which the second increases rapidly in breadth, and presents 7–8 rather broad, slightly curved chambers, which are separated by linear partially obscure sutures. The central volution not externally divided into chambers on the underside, which has a moderately broad umbilicus. Only the last large chamber somewhat protruded. The remainder of the shell is somewhat hollowed out toward the centre. The slightly curved suture narrow, but rather deep. The surface of the shell covered with quite large pores.

1864 F. B. Meek. Check-List of the Invertebrate Fosslls of North America. Cretaceous Formation, Smithsonian Mis. Coll., 177, p. 1.

SUBKINGDOM PROTOZOA.
CLASS RHIZOPODA.
ORDER FORAMINIFERA.
LAGENIDÆ.

2. *Phonemus* (*Cristellaria*) *rotulatus*, (d'Orb.?) Meek.
3. *Phonemus* (*Flabellina*) *cuneatus*, (Morton) Meek.
4. *Phonemus* (*Flabellina*) *sagittarius*, (Lea) Meek.
5. *Phonemus* (*Dentalina*) *pulcher*, Gabb.

Notes and Explanations. (Page 31.)

(Cretaceous.)

3 = *Planularia cuneata*, Morton, Jour. Acad. Nat. Sci., viii. 214, pl. xi. fig. 5.

4 = *Palmula sagittaria*, Lea, Am. Phil. Soc., (1833) Contrib. Geol., 218, pl. vi. Dr. Carpenter unites *Cristellaria*, *Flabellina*, *Dentalina*, *Nodosaria &c.*, as members of a single genus, for which he uses the name *Nodosaria*. It may be at least convenient, however, to retain these names in a subgeneric sense ; but, in either case, we should think Montfort's older name *Phonemus*, should stand for the entire group.

6 and 7.—I have not been able to find by whom these two species were described, but believe it was by Ehrenberg.

1868. F. B. MEEK. Synopsis of the Invertebrate Fossils of the Cretaceous Formation of New Jersey. Appendix A., Geology of New Jersey, 721.

SUBKINGDOM PROTOZOA.

CLASS RHIZOPODA.

ORDER FORAMINIFERA.

LAGENIDÆ.

Phonemus (*Flabellina*) *cuneatus*, Morton, sp. Meek. Cretaceous check-list, 1. *Planularia cuneata*, Morton, Jour. Acad. Nat. Sci., ser. i. viii. pl. xi. fig. 5.

Phonemus (*Flabellina*) *sagittarius*, Lea, sp. Meek. Cretaceous check-list, 1. *Palmula sagittaria*, Lea, Amer. Philos. Soc., (1833) Contrib. Geol., 218, pl. vi. fig. 228.

Phonemus (*Dentalina*) *pulcher*, Gabb. Jour. Acad. Nat. Sci., ser. 2, iv. 402, pl. xviii. figs. 40, 41. Meek Cretaceous check-list, 1.

1869. LOUIS F. DE POURTALES. The Gulf Stream. Characteristics of the Atlantic Sea-bottom off the Coast of the United States. U. S. Coast Survey, 1869. (1872) 221, 222.

Off Long Branch and off Rockaway Beach, near the entrance to New York Bay, the sand contains a large mixture of black grains. They are greensand grains or glauconite, casts of the shells of Foraminifera from the greensand formation of New Jersey, and have been washed out, either from the shore or from an outcropping of the beds under the sea-level.

1870. T. RUPERT JONES, & W. KITCHEN PARKER. On the Foraminifera of the Family Rotalinæ (Carpenter) found in Cretaceous Formations ; with Notes on their Tertiary and Recent Representatives. Quart. Journ. Geol. Soc. Lond., xxviii. 103–132.

On page 108 they refer to A. E. Reuss.——— Die Foraminiferen des senonischen Grünsandes von New Jersey, Palæontologische Beiträge, Sitz. math.—naturw. d. k. Akad. Wiss. in Wien, xliv. 334–340 (1861).

The following synonymy is made.

1. Pl. viii. fig. 1. *Rotalia mortoni* = *Planorbelina Ungeriani.* Thick sub-variety.
2. Pl. vii. fig. 6. *Truncatulina Dekayi* = *Truncatulina lobatula.* Neat form.

On page 121.—" *Pulvinulina repanda* (proper) is represented in the Chalk of Masstricht, but in none of the other cretaceous beds. It is rare in the Tertiaries of our Table (occurring only in the Pliocene), but is scattered throughout the Atlantic. *P. auricula* existed in the Nummulitic sea, abounded in the mid-Tertiary times, and, living now, is abundant in some places ; but it is wanting in the chalk. *P. Menardii*, however, was one of the early representatives of the genus. In New Jersey (North America) it occurs in the Greensand. With us it begins with the white chalk, and has continued with increased prolificness till now. *P. Schreibersii* occurs sporadically in the Greensand of New Jersey."

On page 123, pl. ii. —— the Range of Recent, Tertiary, and Cretaceous Rotalinæ. You will notice three species as being found in the Greensand of New Jersey. *Planorbulina conical*, *P. nautiloid*, and *P. plano-convex*.

1870. HERMAN VON CREDNER. Die Kreide von New Jersey. Zeits. d. D. Geol. Ges., xxii. 191–251.

This article is a general review of the Cretaceous formation of New Jersey, Geological and Palæontological. On page 214 the author gives under Amorphozoa a description of *Flabellina cordata*, Reuss, and *Nodosaria sulcata*, Nils. of which the following is a translation.

Flabellina cordata, Reuss. Böhm. Kr., i. 32, pl. viii. fig. 39.
Frondicularia ovata, Röemer, Kr., 96, pl. xv. fig. 9.

Elliptical, narrowly compressed, about 15 chambers with bow shaped partition-walls ; the first, smallest chamber slightly nodose arched.

Rare in the bryozoan beds at Brownville.

Nodosaria sulcata, Nils.

Römer, Kr., 95.

Nod. Zippei, Reuss. Böhm. Kr., i. 25, pl. viii. fig. 1.

This handsome bodkin-shaped elongated foraminifer is on an average marked by 12 deep constrictions and appears in examples 18 mm. long. The small central, beak-shaped extension of the uppermost chamber and its aperture for the emission of the sarcode are seldom preserved.

Common in the bryozoan bed at Brownville and Turtle Hill.

N. B.—To follow :

Part II. Original Investigations, and remarks.

This part of the paper will consist of the determinations, additions and remarks on the various species found in material collected at Mullica Hill, Timber Creek, New Egypt and several other localities.

NOTES ON ENCLOSING IN COLLODION SECTIONS OF OBJECTS EMBEDDED IN PARAFFIN, AND REGARDING PROVISORY OBJECT-SUPPORT.

BY LUDWIG RIEDERER.

(*Read December 6th*, 1889.)

When working with serial sections for the study of the cellular constitution of animal organs, or for the study of the relative position of the different organs in the body of an animal, the observer often secures a surprising number of sections, usually of large size. As it is possible to inspect these sections only after they are on the slide and finished, the amount of slides and cover-glasses employed, as well as that of time and labor expended is considerable. Consequently only one section out of a smaller or larger number is mounted. It takes some time to finish the slides for inspection, and then it may be found desirable to be able to inspect more of the sections of a certain part of the series.

How then is it possible to preserve and to keep in order the sections, so that, when needed, the desirable ones can be picked out and be found in good condition? It will not do to leave sections lying on the paper, where they are first deposited from the knife, even if they are so kept in a box. The slightest current of air will blow them away, and movement of the box will displace them. Besides this, sections not covered by a proper substance will deteriorate by exposure to the air. Many researches have been made, with more or less of success, to attain the desired end.

I wish to report to some extent the method worked out by Prof. H. Straper of Freiburg, Baden, Germany, and published in the last number of *Zeitschrift für Wissenschaftliche Mikroskopie*, Vol. VI. The article is entitled, "About the treatment of sections of objects embedded in paraffin." Three steps are observed in the method: First; enclosing sections in a film of collodion. Second; placing them on provisory supports. Third; handling the sections while enclosed in collodion, in case the object has not already been stained. It is about the first and second steps that I intend to speak, leaving the third for another time.

The consecutive steps here described are for objects already stained. For enclosing the sections in a film of collodion, there is needed, in the first place, a thin paper of even surface, and evenly saturated with the smallest sufficient quantity of wax or paraffin. This treatment will prevent the solution of collodion from entering the body of the paper. Two solutions of collodion of different composition are used. No. 1 consists of two parts of collodion and one part of castor-oil. No. 2 consists of equal parts of each, all by weight. By means of a large, soft brush a coat of collodion, No. 1, is spread upon the paraffin-paper. On this coat the sections, intended to be enclosed, are laid in order, where they receive a full coat of collodion, No. 2, the presence of air-bubbles being carefully avoided. Then, before bubbles of ether in the interior of the collodion may begin to form, the paper, carrying collodion and sections, is immediately immersed in a bath of spirit of turpentine. The spirit of turpentine hardens the collodion, by extracting the ether, alcohol and castor-oil contained in the solution. Slightly warming the bath quickens the process. The coating of collodion, after immersion in turpentine, first appears milky white, but presently it becomes transparent and colorless, and then the hardening is done.

Now the film of collodion lies isolated in the paper, out of which the paraffin or wax is dissolved by the turpentine. If, while laying the sections on the collodion, a small piece of paper, bearing the number of the adjoining section, is occasionally inserted, this also is enclosed in the film and helps to distinguish sections afterwards desired. The film being hardened and isolated, sections desired for permanent mounting and inspection can be easily selected. They are cut out by means of scissors or knife, and mounted in the regular way in balsam, noting the number or other mark of any section on the label of the slide.

The sections not selected for immediate permanent mounting must then be enclosed in rosin for preservation. To do this take the strips of paper, on which the collodion films rest, out of the turpentine bath ; let the oil drain off as much as possible; transfer them to filtering paper, and remove the surplus oil. The film containing the sections is then covered, by means of a soft brush, with a thick layer of a strong solution of light-colored

rosin in oil of turpentine. The oil of turpentine will be mostly absorbed by the film. Thin writing or tracing paper is then laid on the film, avoiding bubbles. On carefully raising this paper the film will adhere, and can be lifted off the paper it lay on first. A coat of the rosin is then applied to the lower side of the film, and the old paper, or tracing paper put over it. It is allowed to dry on the filtering paper. In case rosin should blot through the paper it is removed with turpentine. Remarks can be written on the covering paper, and the whole plate, or temporary support, is preserved in a portfolio between filtering paper, free from pressure and open to the access of air.

In holding such a plate against the light, it is possible to see at once the coarser items. For inspection under the microscope, the plate is put between a slide and cover-glass, adding oil, creosote, &c. to make the whole more transparent. Whenever then it is desirable to mount permanently single sections, or whole series of them, corresponding pieces of the provisory support are cut out and immersed in the turpentine bath. The rosin being dissolved, the film is separated from the covering paper, and can be mounted in the regular way. On the label of the slide can be marked the numbers, corresponding with the numbers embedded in the film with the sections. In this way it is possible to keep a large number of sections in good condition, easily distinguishable, and always ready for permanent mounting.

PROCEEDINGS.

Meeting of December 6th, 1889.

The Vice-President, Mr. P. H. Dudley, in the chair.

Thirty persons present.

The following Commitees were appointed by the chair:

On Annual Reception; Walter H. Mead, Charles S. Shultz, William Wales:

On Nominations of Officers; F. W. Devoe, F. W. Leggett, William G. De Witt.

Mr. L. Riederer read a Paper, entitled "Notes on enclosing in collodion sections of objects, embedded in paraffin, and regarding provisory support." This Paper Mr. Riederer illustrated

by a demonstration of the process before the Society, and it is published in this number of the JOURNAL, p. 56.

OBJECTS EXHIBITED.

1. A new ½ inch Powell and Lealand Objective: by ALBERT MANN, JR.

2. A "C" Eye-piece of Powell and Lealand, made from the "New Glass": by WILLIAM G. DE WITT.

3. A "C" Eye-piece of Zentmayer: by WILLIAM G. DE WITT.

4. *Drosera rotundifolia*, with captive insect: by GEO. C. F. HAAS.

5. *Utricularia*, with captive insect: by GEO. C. F. HAAS.

6. Diatoms of the genus *Hyalodiscus*: by E. A. SCHULTZE.

7. Diatoms of the genus *Rhizosolenia*: by E. A. SCHULTZE.

8. Spherules from slag of blast-furnace, showing multiple images.

9. Spicules from disintegrated cherty strata; polarized.

10. Quartz crystals from surface of iron ore (Hematite); polarized.

11. Section of fossil Coral; polarized.

12. Diatoms from the lake, creek and springs of Birmingham, Alabama.

13. Selected Diatoms from the same.

Nos. 8–13, inclusive, were prepared by K. M. Cunningham, of Birmingham, Alabama, Corresponding Member of the Society, and were exhibited by J. L. ZABRISKIE.

The Corresponding Secretary read a communication from Mr. Cunningham, containing information on many points of interest in the slides prepared by him, and exhibited, as stated above, and donating to the Society the said slides, together with the following objects and material:

Natural plate of crystals from bituminous coal of Birmingham.

The same, uncovered, showing iridescence by slanting light.

Nodule of fossil coral from Birmingham.

A packet of joints of encrinite stems and crystals from weathered limestone of Birmingham.

Sand from disintegrated chert.

Hollow grains from weathered limestone.

Spherule dust from blast-furnace.

Nodule of chert with spicules.

Calcispheræ in fossiliferous limestone, polished on two sides, from Llangellen, Wales.

Microphotograph, containing forty-eight portraits.

In his communication, Mr. Cunningham stated, that the selected Diatoms—exhibit No. 13—were transferred directly from a strewn slide to the exhibiting slide by the aid of a "Kain's Mechanical Finger," attached to a Beck's ½ inch objective, the slide being manipulated by the left hand, and the bristle being directed into the field from the left-hand side. This method counteracts the effect of reversal of image, enabling every desired movement to be accomplished with ease and certainty. The right hand assists in racking the Diatom from the slide, high enough to clear the edge of the cover-glass, upon which the Diatoms are to be fixed. Very minute species are selected and isolated by this means. And further, that the specimen of fossiliferous limestone from Wales, showing a profusion of Polycystinous bodies—Calcispheræ—may be prized as a relic, from the fact that it was given by Mr. Shrubsole of Chester, England—who first described it to the microscopical world—to Dr. Stolterforth, the eminent diatomist of Chester, who, in turn, gave the rough specimen to Mr. Cunningham.

Meeting of December 20th, 1888.

The President, Mr. Charles F. Cox, in the chair.

Twenty-seven persons present.

The Corresponding Secretary read a communication from the Hon. Marshall D. Ewell, LL.D., Corresponding Member of the Society, entitled "Amplification in Micrometry." This communication is published in this volume of the Journal, p. 4.

Mr. Anthony Woodward read, by title, a Paper, entitled "Synopsis of the cretaceous Foraminifera of New Jersey. Part 1. Review of previous investigations." This Paper is published in this number of the Journal, p. 45.

OBJECTS EXHIBITED.

1. Diatoms from Storen, containing *Suriella spiralis*: by Charles S. Shultz.

2. The Diatom, *Cymatopleura nobilis*: by Charles S. Shultz.

3. The Diatom, *Rhaphidodiscus Febigerii*: by Geo. C. F. Haas.

4. Scales of 30 varieties of South American Lepidoptera: by Thomas B. Briggs.

5. Monazite sand from Brazil: by Thomas B. Briggs.

6. Section of Hydro-magnesite, showing radiating crystallization, from Hoboken, N. J.: by James Walker.

7. Radiating crystals of Hydro-magnesite from Hoboken, N. J.: by Geo. E. Ashby.

8. Section of silicious Geode from the sub-carboniferous shales of Warsaw, Illinois: by J. D. Hyatt.

9. Section of silicious fossil Coral, *Favosites*: by J. D. Hyatt.

10. *Actinophrys sol*: by Stephen Helm, of 417 Putnam avenue, Brooklyn, N. Y.

Mr. Hyatt described his exhibits with the employment of black-board sketches, and stated that the geodes from Warsaw are of all sizes, from one-half of an inch to a foot or more in diameter, and, when broken, they are generally found to be hollow, with the cavity lined with crystals of calcite or quartz. As the formation in which they occur, is entirely calcareous it is not a little interesting to observe, as in this section, the complete molecular change which some of them have undergone. The side of the section representing the exterior is chalcedonic, for the depth of about one-eighth of an inch, showing the radiating fibrous structure and peculiar polarization of that mineral. The interior wall is compact crystalline quartz.

The section of *Favosites* is also completely metamorphosed. The cell-walls of the coral and the structure for a short distance inward are chalcedony, while the interior of each cell is entirely filled with microscopic quartz crystals.

Mr. Helm described his exhibit, and also reported, that on a late occasion he kept a female *Daphnia* in a minute drop of water in a live-box over night, and that on the next morning—after an interval of about eleven hours—he found her still living, and having produced fourteen living young, "all the very image of their mother."

Meeting of January 3d. 1890.

The President, Mr. Charles F. Cox, in the chair.

Twenty-nine persons present.

Miss Mary A. Booth, of Longmeadow, Mass., was elected a Corresponding Member of the Society.

The Committee on Nominations of Officers, appointed at the meeting of December 6th, 1889, reported their nominations of the persons who were unanimously elected, as is stated below.

The President appointed as Tellers of the election of Officers Mr. H. W. Calef, and the Rev. Geo. C. F. Haas.

The annual Reports of the Treasurer and of the Committee on Publications were presented and adopted.

The President, Mr. Charles S. Cox, delivered his Annual Address, entitled "Protoplasm and the Cell Doctrine." This Address is published in this number of the JOURNAL, p. 17.

OBJECTS EXHIBITED.

1. The Diatom, *Rhaphidodiscus Febigerii*, Smith: by E. A. SCHULTZE.

2. Alimentary tube of the Blue-bottle Fly, *Musca* (*Lucilia*) *Cæsar*, L., exhibited in its entire length from œsophagus to rectum, with some of the neighboring organs, as glands, malpighian vessels, tracheæ and ovarian tubes containing eggs: by L. RIEDERER.

The President announced the closing of the polls, and declared the result of the balloting to be the election of the following persons as Officers of the Society for the present year:

President, P. H. DUDLEY.

Vice-President, J. D. HYATT.

Recording Secretary, BASHFORD DEAN.

Corresponding Secretary, J. L. ZABRISKIE.

Treasurer, CHARLES S. SHULTZ.

Librarian, LUDWIG RIEDERER.

Curator, WILLIAM BEUTTENMÜLLER.

Auditors, { F. W. DEVOE, W. R. MITCHELL, F. W. LEGGETT.

MEETING OF JANUARY 17TH, 1890.

The President, Mr. P. H. Dudley, in the chair.

Twenty-five persons present.

The President delivered his Inaugural Address.

Mr. Alfred L. Beebee, was elected a Resident Member of the Society.

Mr. Charles F. Cox gave notice of a proposed amendment of Article X of the By-Laws of the Society, striking out the words "roll-call," wherever they occur in said Article.

On motion, the resignation of the members of the Committee on Annual Reception, because of their inability to devote their time to the labor necessarily required from such Committee, was accepted.

The President appointed the following persons as Committee on Annual Reception: Charles F. Cox, Anthony Woodward, James Walker.

The following were appointed as a Committe to procure six objectives, of moderate power and cost, for the use of the Society: J. D. Hyatt, J. L. Zabriskie and William G. De Witt.

The following were appointed as the Committee on Publications: J. L. Zabriskie, William G. De Witt, Walter H. Mead, John L. Wall and George E. Ashbey.

OBJECTS EXHIBITED.

1. Sections of Basalt, containing native iron, from Ovifak, Greenland: by JAMES WALKER.

2. The fungus, *Sporocybe cellare*, Peck, new species, showing capitulum and spores: by J. L. ZABRISKIE.

3. Spiral tracheids of Yellow Pine, *Pinus palustris*, Mill.: by P. H. DUDLEY.

4. Spiral tracheids of White Cedar, *Chamæcyparis sphæroidea*, Spach: by P. H. DUDLEY.

Slides of diatomaceous deposits from the Yellowstone Geyser region: by C. HENRY KAIN;

5. Deposit from the Yellowstone Lake.
6. Deposit from Norris's Meadow.
7. Deposit from Geyser Meadow.
8. Deposit from Nez Perces Creek.
9. Deposit (amorphous silica) from Sulphur Hill.

Mr. Dudley read a Paper describing his exhibits.

Mr. Kain stated concerning his exhibits, that this material from the Yellowstone Geyser region was presented to him by Mr. Walter Harvey Weed, of the U. S. Geological Survey. The diatoms contained are ordinary fresh-water forms, but there are

some points of more than ordinary interest connected with them.

Mr. Weed has described—Botanical Gazette, xiv, 117—the vast diatom-marshes of the Yellowstone National Park, which owe their origin to the fact that the water from the geysers is highly charged with silica.

The crude material appears to be composed of vast numbers of diatoms, associated with the dried gelatinous matter, which usually accompanies such deposits. The usual methods of cleaning the diatoms by boiling in the mineral acids, however, almost entirely fail with these deposits, for the reason that what appears at first to be only the usual accompanying organic matter is in reality silicious sinter. An attempt to get rid of this by boiling the deposit in caustic potash resulted in the destruction of the diatomaceous frustules, while the sinter itself was scarcely attacked.

The deposits are quite similar in regard to the character of the species found, the largest forms, however, occurring in the cooler waters of the Yellowstone Lake.

This subject was discussed by Mr. E. A. Schultze and Dr. N. L. Britton.

Mr. Kain donated the five slides of his exhibit to the Cabinet of the Society.

PUBLICATIONS RECEIVED.

The Microscope: Vol. IX., Nos. 10, 12—Vol. X., No. 2 (December, 1889, February, 1890).

The American Monthly Microscopical Journal: Vol. X., Nos. 10, 12—Vol. XI., Nos. 1, 2 (October, 1889—February, 1890).

The Microscopical Bulletin and Science News: Vol. VI., No. 6 (December, 1889).

Anthony's Photographic Bulletin: Vol. XX., No. 23—Vol. XXI., No. 5 (December 14, 1889—March 8, 1890).

Entomologica Americana: Vol. V., No. 10—Vol. VI., No. 3 (October, 1889—March, 1890).

Psyche: Vol. V., Nos. 160-166 (August, 1889-February, 1890).

Insect Life: Vol. II., Nos. 5-8 (November, 1889-February, 1890).

Bulletin of the Torrey Botanical Club: Vol. XVI., No. 12—Vol. XVII., No. 2 (December, 1889-February, 1890).

The Botanical Gazette: Vol. XIV., No. 12—Vol. XV., No. 1 (December, 1889-January, 1890.)

The School of Mines Quarterly: Vol. XI., Nos. 1, 2 (November, 1889–January, 1890).

San Francisco Microscopical Society, Proceedings (December 11, 1889).

Natural Science Association of Staten Island, Proceedings (December 12, 1889–February 13, 1890).

Johns Hopkins University, Studies from the Biological Laboratory: Vol. IV., Nos. 5, 6 (November, 1889–February, 1890).

New York State Museum, Fifth Report of the Entomologist (1889).

American Academy of Arts and Sciences, Boston: Proceedings: Vol. XXIII., Part 2 (1888).

The West American Scientist: Vol. VI., No. 49 (November, 1889).

Kansas Academy of Science, Transactions (1887–88).

Washburn College Laboratory, Bulletin: Vol. II., No. 10 (December. 1889).

Agricultural Experiment Station, Alabama; Bulletins, Nos. 8, 10 (November, 1889, January, 1890); Science Contributions, Vol. I., No. 1 (December, 1889).

Cornell University College of Agriculture, Bulletins: Nos. 11–15 (November–December, 1889).

Agricultural College of Michigan, Bulletins: Nos. 54–56 (October, 1889–February, 1890).

Museum of Comparative Zoölogy, Cambridge, Annual Report (1888–9).

The Brooklyn Medical Journal: Vol. IV., Nos. 1–3 (January–March, 1890).

The Satellite: Vol. III., Nos 4–6 (December, 1889–February, 1890).

The Hahnemannian Monthly: Vol. XXIV., No. 12—Vol. XXV., No. 3 (December, 1889–March, 1890).

The Medical Analectic and Epitome: Vol. VI., No. 49—Vol. VII., No. 1 (December 5, 1889–January, 1890).

Indiana Medical Journal: Vol. VIII., Nos. 6–8 (December, 1889–February, 1890).

The Electrical Engineer: Vol. IX., Nos. 97, 98 (January, February, 1890).

The American Lancet: Vol. XIII., No. 12—Vol. XIV., No. 2 (December, 1889–Februray, 1890).

The Pacific Record of Medicine and Surgery: Vol. IV., Nos. 5–7 (December, 1889–February, 1890).

National Druggist · Vol. XV., No. 12—Vol. XVI., No. 5 (December 15, 1889–March 1, 1890).

Mining and Scientific Review: Vol. XXIII., No. 21—Vol. XXIV., No. 9 (December 5, 1889–February 27, 1890).

The Canadian Record of Science: Vol. III., No 8—Vol. IV., No. 1 (October, 1889–January, 1890).

Nova Scotian Institute of Natural Science, Proceedings: Vol. VI., Part 2—Vol. VII., Part 3 (1883–89).

The Ottawa Naturalist: Vol. III., No. 3 (October, 1889).

The Canadian Institute: Proceedings, Vol. VII., No. 1 (October, 1889); Annual Report (1889).

Natural History in Elementary Schools; by H Hensoldt, Ph. D. (1890)

A Naturalist's Rambles in Ceylon; by H. Hensoldt, Ph. D. (1889).

The New York Free Circulating Library, Annual Report (1889).

Grevillea: No. 86 (December, 1889).

Journal of the Royal Microscopical Society: 1889, Parts 6. 6a; 1890, Part 1.

The Journal of Microscopy and Natural Science: Vol. III., No. 1 (January, 1890).

The Journal of the Quekett Microscopical Club: Vol. IV., No. 26 (January, 1890.

The Naturalist: Nos. 173–175 (December, 1889–February, 1890).

Field Naturalist's Club of Victoria, Ninth Annual Report (1888–89).

The Victorian Naturalist: Vol. VI., Nos. 7–9 (November, 1889–January, 1890).

Bulletin de la Société Belge de Microscopie: Vol. XVI., Nos. 1–3 (October–December, 1889).

Naturwiss. Verein d. Reg.-Bez. Frankfurt a O.: Mittheilungen, Vol. VII., Nos. 6–7 (September, October, 1889); Societatum Litteræ, Vol. III., Nos. 7–8 (July–August, 1889).

Wissenschaftlichen Club in Wien: Monatsblätter, Vol. XI., Nos. 2–4 (November, 1889–January, 1890); Ausserordentliche Beilage, Vol. XI., Nos. 2–4.

Société Royale de Botanique de Belgique: Comptes-Rendus (November 9, 1889–February 8, 1890); Bulletin, Vol. XXVIII., No. 2 (1889).

Bolletino della Società Africana d' Italia: Vol. VIII., Nos. 5, 6 (May, June, 1889).

Nuovo Giornale Botanico Italiano: Vol. XXII., No. 1 (January, 1890).

Kongl. Svenska Vetenskaps-Akademien, Transactions: Vol XII., Nos. 3, 4 (1887, 1888).

Die Grundlagen der Bakteriologie; by A. P. Fokker (1889).

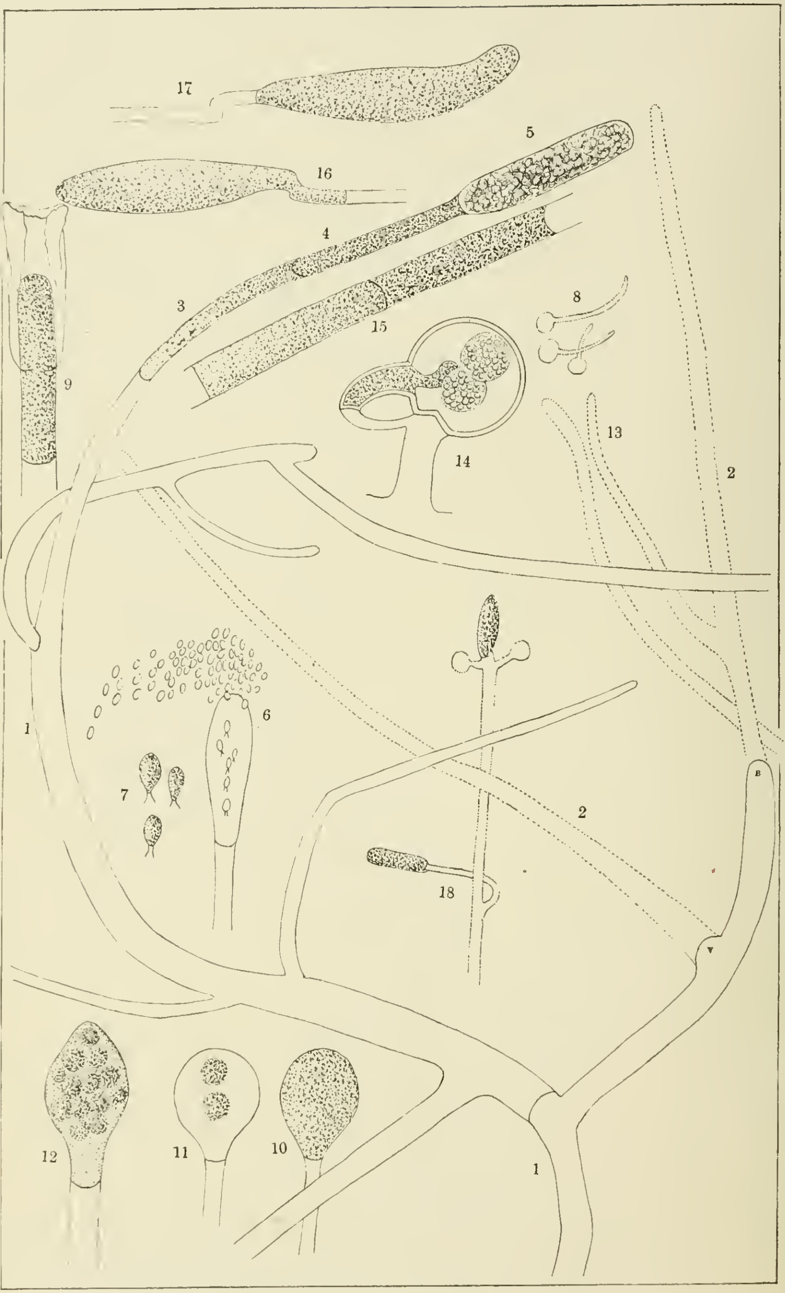
Naturforschende Gesellschaft zu Freiburg, Berichte: Vol. III.—Vol. IV., No. 5 (1888, 1889).

Mémoires de la Société des Naturalistes de Kiew: Vol. X., No. 1 (1889).

Bulletin de la Société des Naturalistes de Moscou: 1888, No. 4; 1889. No. 1.

Sitzungsberichte der konig. böhm. Gesell. der Wissenschaften, Prag: 1889, Part 1.

Memorias de la Sociedad Cientifica "Antonio Alzate": Vol. III., Nos. 1, 2 (July, August, 1889).



LOCKWOOD ON SAPROLEGNIA.

JOURNAL

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FUNGI AFFECTING FISHES—AN AQUARIUM STUDY.

FIRST PAPER. SAPROLEGNIA.

BY SAMUEL LOCKWOOD, PH. D.

(*Read March 7th*, 1890.)

Does it not appear like the disciple's being above his master when he rides his hobby at such a technical rate that one even fairly informed cannot keep up with him? But then it seems erudite, and *more Germanico!* Still, I think, the light of science should not be darkness; and the most of us know how easy it

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Description of Plate 22.

1, 1, Thallus of *Saprolegnia ferox*. Its peculiar branching induced the drawing. The heavy lines show the old plant; the lighter ones, *2, 2,* the part which grew while under observation.——Time, 55 minutes. The points, *A, B,* of course, disappeared, each in the continuity of its own cylinder.

13, Where the two young hyphæ met and nearly touched but diverged.

3, A cell in which the protoplasm has turned into germ, or spore-plasma, and has begun to granulate. *4,* A cell in which granulation has advanced. *5,* A sporangium, or mother-cell, in which the spores are nearly ripe. *6,* A sporangium from which the zoospores are escaping, as motile, or swarm-spores. In this cell are six spores unable to leave. *7,* Three zoospores greatly enlarged, showing their cilia, and general amœboid condition. *8,* The same, having become spherical and invested in a membraneous shell, and now germinating.

9, A forthcoming sporangium growing through the remains of an empty sporangium, such as may be predicated of cell *4*, when cell *5* is empty.

10, An oogonium in which the protoplasm has become spore-plasma and is granulating.

11, An oogonium whose contents have been taken up in making two oospheres, which are to be the ultimate spores of this *Saprolegnia ferox*.

12, An oogonium full of oospheres, the crowding of which is lengthening the capsule at the top, where the rent will occur for the emission of the spores. These oogonia in the specimens studied were much varied in form, some being almost cylindrical, some globular, the normal form being flask-like.

is to follow the great masters of knowledge. Your reader, who is not a fungologist, without pretending to much that is new, will try to tell in a comprehensible way, the story of what was seen and done in a winter's attention to the sick fishes in his aquaria. Happily, this much can be safely promised: However threatening may be a theme dealing with disease and death among one's pets, our subject shall not be repulsive, though it is true that in such, or kindred pursuits, the inquirer does upon occasion find himself a little tried.

A very pretty thing is one of these microscopic fungi, and in some roles they are the elfins of goodness. But alas they do sometimes appear as sprites of malevolence ; for how often does the student see them in unlovable situations, almost dampening his devotion with disgust, if not tempting to an outburst of mild profanity. He has mounted a precious rarity in a dry cell. It proves a "sell" that is not dry—but serious. There was just enough moisture in that little air-tight chamber to nourish a mischievous stowaway, a concealed fungus spore, and the rarity is enveloped in a shroud of mold. I recall a scene. I was at my summer retreat, and the obliging postmaster at home had forwarded a little box stamped at letter rates. Boniface Pry followed me to my room against my wish. The opened package contained a dead mouse, killed by a fungus. The stench emitted on opening the box was indescribable, driving my host to the outer door, where, pinching his nostrils with thumb and finger, and mistaking my interest for insensibility, he exclaimed: "Can you to-lu-rate that o-di-us smell?" How singular! The man's dialect, especially his peculiar prolongation of the vowels suggested a scientific diagnosis. Yes, that fungus which killed the mouse had been pronounced either a Torula, or an Oidium.

Previous to the above event, Dr. Leidy had exhibited at a meeting of the Philadelphia Academy of the Natural Sciences a mouse caught in the children's department of the Blocksley

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14, An oogonium, showing the antheridium fertilizing the oospheres. After De Bary.

15, A broken hypha, showing two cells with the granulation of the protoplasm well advanced. It was in these cells that the phenomenon of cyclosis was witnessed.

16, *17*, Curious abnormal forms of sporangiæ. In *16* the septa is below the elbow, and in *17* it is above.

18, A branched hypha; below is a small incipient sporangium, and at the apex another, with what seems to be an incipient oogonium at each side.

In this plate no attention has been given to the magnification.

Hospital. The ears, nose, and side of the face were covered with a white mold, which had eaten into the flesh. The Doctor thought it resembled the Aphtha, or thrush fungus. He even intimated that the animal might have been eating crumbs dropped by children having the thrush.

The role of these microscopical fungi is universal, in the earth, the waters, and the air. No class of animal or vegetable form is exempt from these minute parasites, and descending to their relatives, the microbes, we reach the propagators of the pestilence in man and beast, as the thrush fungus, *Oidium*, or *Saccharomyces albicans*, which attacks the mucous membrane of the mouth and throat of children. But the fungus which causes the skin disease known as favus, the *Achorion Schoenleinii*, is much like a *Torula*, and is often fatal to rodents, and the distance is not far from this parasitic ærial mold to the parasitic aquatic mold, represented by the *Saprolegniæ*, which beget terrible skin diseases on the cold-blooded animals, newts, frogs, and fishes.

Last October a friend in Trenton, N. J., caught for my aquarium a number of the two species of sunfish, *Enneacanthus simulans*, the spotted sunfish and *Mesogonistius chætodon*, the black-banded sunfish. To await my coming for them they were put in a tub in the yard, supplied with the city water from the Delaware When I called it turned out that many of them were attacked by the fungus, which afterwards proved to be chiefly *Saprolegnia ferox*. I picked out eighteen that seemed to be unaffected. These were introduced into a large aquarium, containing already some fifty fishes of ten species. Alas! it was soon evident that the pestilence had invaded the little community. In three days I could see the mold whitening on some of the Trenton fishes. Another aquarium was arranged at once as a quarantine, into which every infected fish was put as fast as detected. Besides the two sunfishes mentioned, I already had another species in the tank, *Lepomis gibbosus*, the common pumpkin-seed. Curiously the inmates of the hospital were all sunfishes excepting a pirate perch. My treatment was painfully unsuccessful. In about six weeks I had lost twenty-four sunfishes by the fungus. This included all my Trenton fishes, save a solitary one—an adult.[1] I had even at intervals emptied, and

1. Since the above was read to the Society I find that a pirate perch has succumbed to the fungus.

as thoroughly as I could, cleaned out the quarantine hospital. I also had a still smaller aquarium into which I removed from the hospital such as I thought might be convalescing.

It must be that there are constitutional differences in fishes, even of the same species. The one I saved was an adult black-banded sunfish. Supposing it to be cured, I restored it to the large aquarium, and in three days I saw symptoms of a second attack of the malady. The fishes thus suffering would rub themselves by swimming rapidly against a stone. But this could only touch the sides of the animal; thus the head and back would have an unbroken white coating not unlike cotton. I hastily returned the "Bandie" to the hospital, where he soon improved, and was then transferred to the little aquarium, which I called the sanitarium, and was allowed to stay there; thus a complete cure was effected.

So far as my time would permit I submitted specimens of the fungus to the microscope, and was rewarded with some good displays of the methods of growth, and although not altogether original, it will, I hope, not be amiss if in a brief way the life progress of the plant be given.

Reference has been made to the *Aphtha*, or the parasitic fungus of thrush. This is known as a sprouting fungus. The spores arranged in irregular rows, each sprouts at one end, not unlike grains of wheat. Suppose a row of such grains, each one just where it grew, bursting and sprouting, first on one side of the row, then on the other, that is, alternating though irregularly, and we should have a fair picture of the process. But our parasitic *Saprolegnia* proceeds very differently. The motile spores, or zoospores, we will suppose, have swarmed, and escaped, or been emitted from their sporangium, or generative sac. They are now on their travels in the water, for each one has its propelling cilia. Having found a staying place and undergone a change, to be described, either immediately or after due waiting, germination begins. A slight pimple appears on the surface of the spore. It is not a bud or a sprout protending through a debiscence, as in a seed—but a pushing out of the skin itself, until it is prolonged into a little tube, like the finger of a glove. This tube grows, becoming a mycelium or hypha, really a hollow or tubular thread. Of these thread-tubes or filaments, is the plant

mass or vegetative system of our fungus chiefly composed. The base of each mycelium is rhyzoid, that is, though not in form, it is in function root-like ; for as rootlets these basal ends penetrate the solid tissues, and suck or extract the nitrogenous nutriment. We may call the outer parts the fronds or branches, as they are the fruit-bearers, the spore capsules, of which our *Saprolegnia* has two kinds on the same plant. One of these, borne at the end of the hypha, is club-shaped, or with its hollow support looking in the microscope exactly like a miniature bullrush. This is called a sporangium, and its contained seed-like bodies are known as motile spores, or zoospores, because of certain animal-like movements.

There is another kind of capsule, usually terminating a short hypha. It is usually flask-shaped, though sometimes globular. This is known as an oogonium, literally, egg-bearer. Its contained round bodies are called oospheres, or egg-spheres. They are much larger than the zoospores, and these quasi animal appellations are given them because they have to be fertilized, unlike the seedlets in the sporangium, already noticed as zoospores, or motile spores. In a word these tiny oospheres have a similar necessity to the ovule in a flower, which owes its life force to the pollen from the anther. So to meet this need in our fungus capsule a bud is seen to grow from the pedicle or neck of the oogonium, that is, the capsule containing the spores. This curious organ grows rapidly, and is developed simply in the nick of time; that is, when the oospheres are just on the eve of maturity. At first it is merely a little tube, just long enough for its tip to reach the flask-like capsule above it. Now a change rapidly occurs. A septa or dividing plate grows in the tube, thus making the upper end a cell. This is filled with protoplasm, which now separated from the protoplasm below the septa, is affected by some special action of organic chemistry, and becomes a little opaque, and changes into a substance known as gonoplasm. It is now charged with a communicable life essence. At this point of time, from the centre of the disc made by the tip of the cell flattened against the outer wall of the capsule, the tube in a much smaller diameter, thus having a shoulder around it, is lengthened, penetrating the oogonium at a weak spot until the tip of this tube so lengthened reaches the nearest one of the con-

tained oospheres. It gently touches this little spherical mass of naked protoplasm, the nucleus of which coalesces with the imported gonoplasm. The oosphere now takes on a covering, and thus becomes a cell, and is endowed with a peculiar life force, and is recognized as an oospore. It is complete, and for its own species, the ultimate or highest possible productive spore. As such, though perhaps indefinite, it has an advantage over the zoospore, and with this superiority it starts on its own career. As to that little fertilizing organism, because of its likeness in function to that of the anther in a flower, it is called an antheridium.

One must feel assured that this complexity of mechanism is not a superfluity of nature. In the long run this organic inter-relation is indispensable to the continuance of the species in its normal integrity, yet these lowly plants are possessed of a marvelous plasticity of accommodation to the situation of circumstance. The *Saprolegnia* can be a saprophyte, that is, a dweller on some inorganic thing, a stick or a stone. But it only revels in its life role as a parasite, its host being a living thing. So for a while there seems at times an arrest, or break in the process of development. The symbiosis of the brood-sac is dispensed with, and the simple sporangium capsule with its motile spores is made to suffice. The play of life is for the occasion gone through, with the prince left out, or perhaps the metaphor is more apposite, the establishment while awaiting developments is content to graduate sophomores.

A fungus, as we are now considering it, is a vegetative body without stem or leaf, and such a body, not reckoning the parts necessary for fructification, is called a thallus. This is composed of cylindrical threads or filaments which sometimes branch. They are really tubular membranes filled with protoplasm, and growing or lengthening at the apical end. Each thread may be called a hypha, while a mycelium may consist of one or more hyphæ. As the hypha lengthens septate divisions occur in the tube, thus separating it into cylindrical cells ; and these may become spore-sacs, the top one developing first.

The saprolegnia mold is usually a floccus of straight threads, standing out like hair. Noticing in some fungus just taken

from a dying fish, that the mycelia were very much branched, I undertook to draw a plant as seen under the microscope. Truly I was entertained with an interesting sight. I got badly bothered on my drawing, being somehow unable to keep the parts in their relative proportion. It was as if an artist, after outlining a face, should find the nose lengthening to elephantine dimensions. The truth was, I was attempting to draw some mature hyphæ, unconscious of the fact that young hyphæ were growing under my eyes. Of course, while the older parts of the plant remained stationary, the young parts kept advancing in the field because they were growing, thus lengthening. My first assurance of this was that a spur or bud-like projection from a hypha which I had drawn had begun lengthening, and had become a young hypha itself. I at once noted the time my observations extended through, fifty-four minutes by the watch. It is like witnessing the work of a mysterious hidden hand, when one follows this steady growth. How noiselessly the hyaline cylindrical thread, with its membraneous wall of cellulose lengthens! And how is it done? All the time it is full of that subtle life-stuff, protoplasm. Now I see it swelling out at one spot like a bud; this elongates, and in fact branches. It is also noticeable that here and there a septum forms dividing the cylinder into sections or cells. The contents of these cells become increasingly opaque; for the molecules of the invisible protoplasm are now aggregating into visible granules. This differentiation is the most advanced in the apical or top-most cell, for here the granules are further aggregated into roundish masses of granules. These when ripe will be the sporules, or zoospores. The cylindrical cell which now contains them is their sporangium. And here two facts are observable: the enlarging of these immature sporules produces a crowded situation, so that for a while their form is affected from squeezing. They are a little polygonal instead of spherical, and the other interesting fact is that the cell must expand under this internal pressure; hence we have in form the head of a bullrush. A moment comes when under this internal pressure there is produced a crack or slit at the tip. With the inlet of pure water and free oxygen, there comes a sudden and final expansion of the sporules, and a resulting escape at the apex of the sporangium.

It was a very interesting sight when I saw for the first time this emission of the sporidia from the sporangium or mother-cell. All kinds of similitudes came to mind, from that of bees swarming, to the letting out of an unruly rural school. Like the latter, it was a quasi jail delivery. It is a real liberation of the sporules. The disquietude begins at the back seats, or dropping figures at the bottom of the capsule, or sporangium. The commotion thence ascends until those at top are affected, when at the small opening these motile spores rush out in a swarm and sail dispersedly away. I noticed a few, maybe six, remaining in the evacuated capsule. They seemed uneasy. The opening at the top of the sporangium had closed. Though showing movement, they had lost the momentarily given impulse which enabled the others to squeeze through, and "get out." It was the old adage of "time and tide" over again, for they were "kep' in."

Here I will quote Hines' description : "Just before escaping the zoospores at the base always take on an oscillating motion, which passes to the zoospores next above, and so on to the summit, causing such a pressure that in less than a minute the power is such as to cause a rupturing of the sporangium, which in normal conditions always takes place at the summit. The zoospores now pass out at first very rapidly, so that it is impossible to count them, but when about one-half out they become more quiet, seldom losing their motion, however, until all have passed from the sac. In passing out they are very much constricted, so that if any lose their power of motion before they have escaped, it is impossible for them to pass out. Having passed from the sporangium, which was emptied in one minute, they swarmed around very lively for nearly four minutes, at the end of which time they settled down, lost their cilia, and became spherical. At the end of one hour and thirty minutes, they had germinated."

The process of liberating the spores in this species of *Saprolegnia* is much simpler than in those species known as *Achyla*. In these the emitted spores gather at the tip of the sporangium, or place of emission, in a globular cluster-swarm. They are seemingly naked bodies held together by their own cohesion ; but now each spore is suddenly invested with a mem-

brane, which very soon dehisces, and out of this spherical cell comes its occupant, somewhat bean-shaped or pseudo-crescent, if you like, with two cilia by which he sails away, a bashaw of two tails, leaving his jacket behind him.

De Bary, says: "The distinguishing mark of the *Saprolegnia* is that the spores are in the motile state as they issue from the sporangium, and that the branch of the thallus which bears the sporangium grows through it when it has discharged its spores." The walls of the emptied sporangium have become much thinned through absorption by the sporidia, so that the cylindrical section below, which is to become a sporangium, grows through this emptied capsule, becoming in its place the apical cell. The sporules thus emitted are at once motile spores, zoospores, or quasi-vitalized seeds, ready to germinate after a little change. It is like taking a shortened course, in which the symbiosis in Nature is dispensed with for the nonce and, strictly speaking, this is nowhere so anomalous as in these very fungi, where the laws of fructification are peculiarly complex. The common grape vine fungus now so destructive, passes in its development through eight stages or forms of spore, ere the ultimate spore form is reached.

We have seen that the motile spore or zoospore of the sporangium plays much the simpler role. Yet even this spore is subject to curious changes. In the *Saprolegnia* it emerges in an ovoid form, with a pair of cilia. It is then little more than an amœboid. It is not a cell proper. But this may need a word.

No one has seen the film which holds the contents of the dewdrop. This is left to conception. An amœba is the simplest form of animal life—a speck of sarcode, tissueless, a structureless living animal substance. Now when we see it pushing out pseudopodia and retracting them, we must conceive a peripheral or containing layer or film of the protoplasm or sarcode; so is it with our motile ovoid sporule when it leaves the mother-cell, the sporangium. Its cilia are simply projected tubes of the peripheral film. With these it can turn upon itself and propel itself also. Its travelling soon ends, when it comes to rest, and its cilia are withdrawn, in fact absorbed. Very soon this ovoid amœboid spore becomes spherical, and is invested

with a cellulose membrane—in fact it has become a globular cell. If now excused further change it pushes out a tubule, which elongates by growth. This is its germination, and this tubule becomes a hypha, the beginning of a new thallus or plant.

We said if excused further development; for in some, even at this stage of being, a spherical cell, it is denied the privilege of germinating. The cell will crack open, the protoplasm emerge, a lentil form be taken on; in a word, it becomes a swarm-spore a second time ere it becomes a germinating spore.

This may be seen in Fig. 1, plate 23. Here the spores are invested with a membrane; they are cells of granular protoplasm. But they are bursting through the sides of the mother-cell, instead of at the tip, and curiously they leave their shells behind them—actually entering their aquatic world in an amœboid condition. This seemingly anomalous thing is a *Dictyuchus*, another genus of these *Saprolegniæ*. A curious feature in this sporangium is the pressure of subsidiary mother-cells, for it is cut up into small sections.

With the exception of the species just described I think all were the common *Saprolegnia ferox*. But the eccentricities or diversities of growth were many and striking.

I found myself greatly interested in a peculiar exhibition of the phenomenon of cyclosis, or circulation in these filament cells of *Saprolegnia*. In the early stages of the granulating of the protoplasm in a cell destined to be a sporangium, I observed the circulation, or movement of the particles of the granulating protoplasm. The movement was very lively, but not that stately

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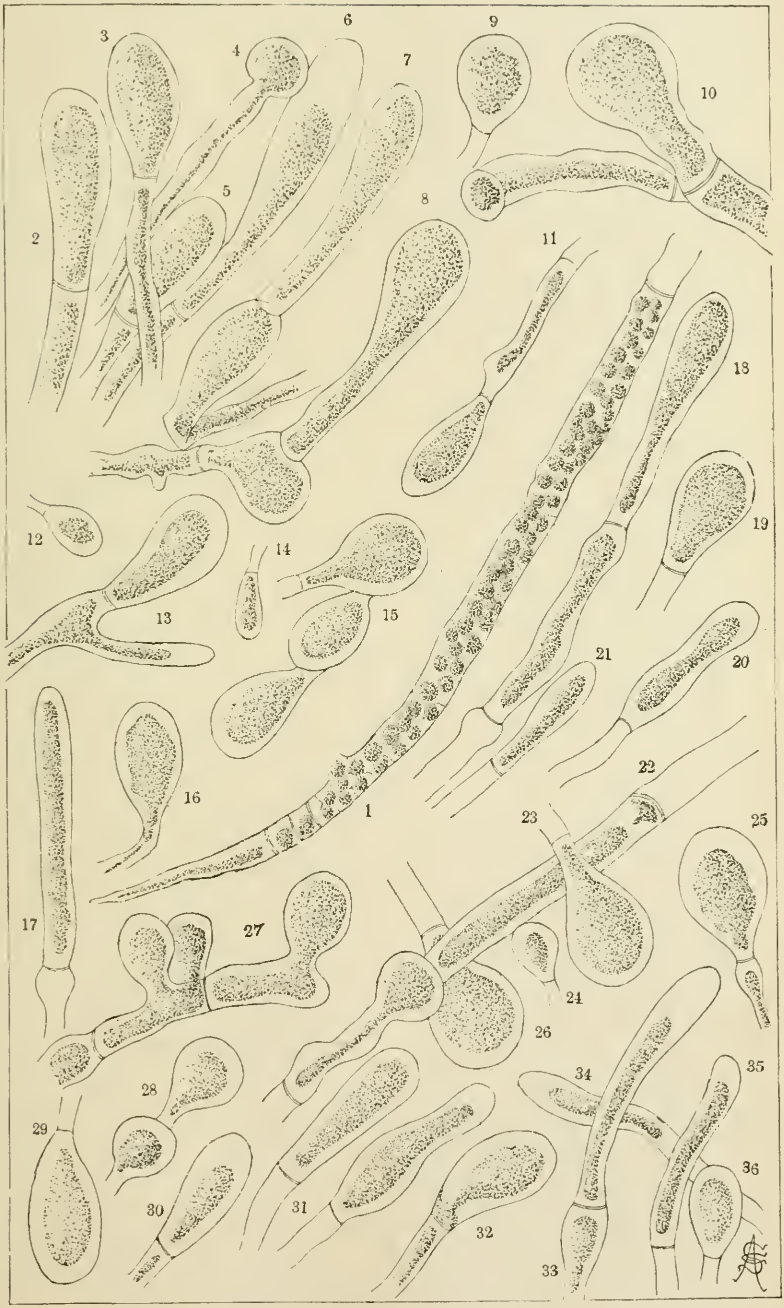
Description of Plate 23.

1, A compound sporangium of *Dictyuchus* one of the *Saprolegniæ*. One of the spores is breaking through the side, which is the only way to gain emission, for there are several septæ, making approach to the apex impossible, nor is the apex of a suitable form for such a mode of escape. It was evident in the original, and is indicated in the drawing, that the swarm-spores were already invested each with a shell, which it left behind in the mother-cell or capsule, and entered the swarm state in an amœboid condition.

The figures in this plate were drawn from specimens mounted in glycerine, and the effect has been to contract the protoplasm, thus making it leave the cell walls. The object of the drawing is to show the variability, even eccentricity of forms, and the figures are numbered simply for convenience of reference. The magnification is about 500 diameters.



LOCKWOOD ON DICTYUCHUS.

and almost rhythmic flow or streaming which one sees in *Nitella* and *Vallisneria*. It seemed to me more like the purposeless impulse of the motes in the sunbeam. The scene was very pretty; for though seemingly crowded I could not detect any jostling in the mazy movement, which would hardly be compatible with the fact that these were naked bodies. There was a glitter, too, which indicated a variation of surface and an individual movement like turning on an axis.

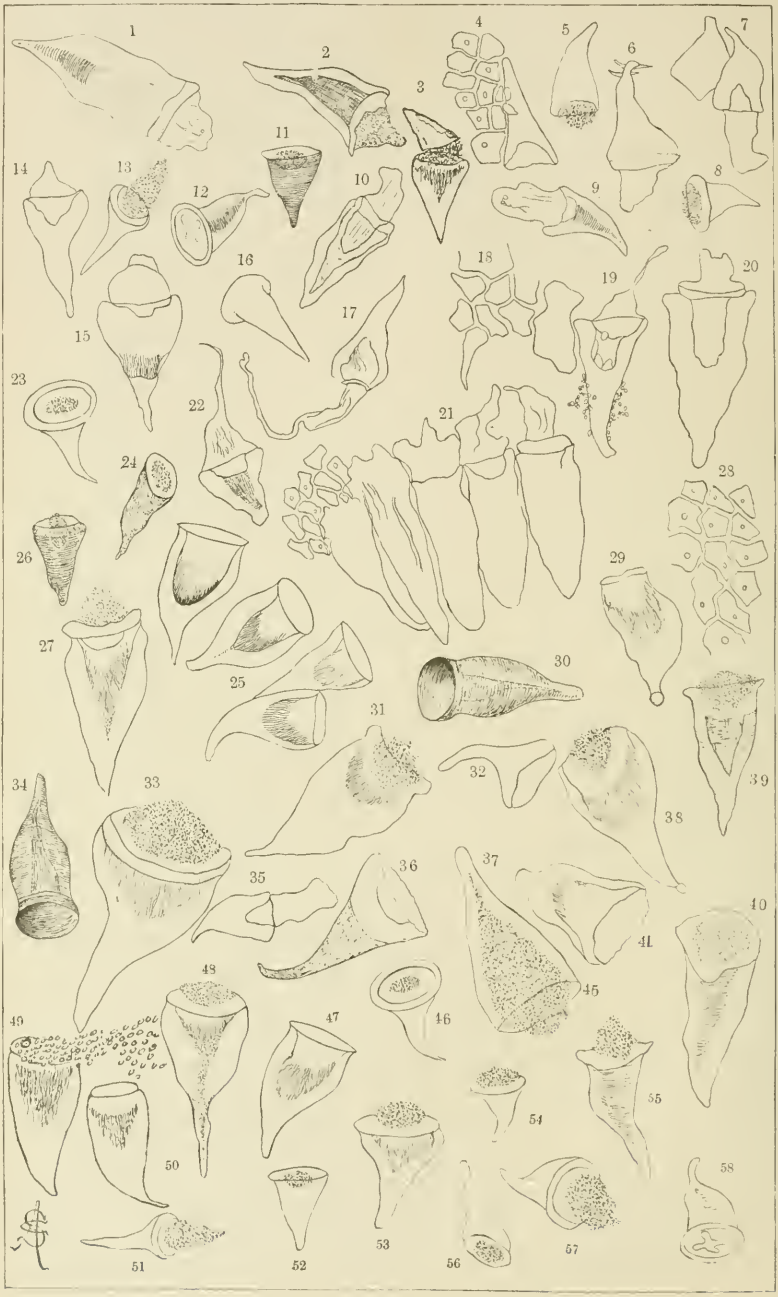
But in respect of motion in these lowly plants there is a sensitiveness which is strikingly like instinct. As the several hyphæ grew under my eye two proceeded side by side, coming at their extremities nearer and nearer. At last I thought they must collide; so, to be in at the catastrophe I watched them intently. But the little things seemed to know their interests better. They came so closely that I could only just see the space between them, when, as if each regarded the contiguity of the other as undesirable, without even touching, each at the same instant started for itself a growth in a diverging curve, and thus they separated, as if upon a mutual understanding. It certainly did look like an amicable compact to get out of each other's way quietly.

Should it now be asked, have we not a fungicide? My answer is not favorable. As regards aquarium fishes I have heard suggested the bathing them in a solution of carbolic acid. But this is impracticable. The solution must be weak, it must not be allowed to touch the gills, and the application must be rapidly done. I remember the late Dr. Henry J. Rice, who in the biological laboratory over Fulton Market had under his care some valuable Japanese goldfishes thus diseased. He expressed himself to me in favor of this treatment, though in his own trials it had failed to save the fish, which must succumb if the acid is applied strong enough to kill the fungus. Let us call it what we will—vitality, constitution, or what not—there is in individuals of the same species differences of power to resist disease. Could an eagle unduly divert muscle making into wing growth, it would become one of the very weakest of birds. This very increase of pinion thus obtained would mean decrease of power; so is it with these Japanese fishes. The muscles have gone largely into fins. Their owner is a coddled, weakly thing. Let disease attack, it is without repellant or sustaining power. Now

it is very different with this same species in its normal state. Among the fishes which occupied my attention this past winter were two of these Crucian carps or gold-fishes, *Carassius auratus*. One of them was the true golden, and the other the pale or silver variety. Neither of these were affected by the fungus, although about a year previous the pale one had a very severe attack of the *Saprolegnia*. I saved it by temporary isolation from the rest.

It must be, I think, that the oospores have in some instances long rests, so that they appear at intervals, even as epidemics; as for example, the *Achyla*, that formidable species of the saprolegnia group, which sometimes so greatly injures the salmon. What may be the sufferings of these cold-blooded creatures when succumbing to this scourge, one cannot say. To me it has appeared to be considerable. Truly pitiable is the sight of one of these pretty creatures when in the throes of death from an attack of this fungus disease. Each fin is now collapsed like a closed fan whose folds are held in the meshes of an agglutinated web. From tail to nose it is invested with a white, gnawing, morbific shroud, with here and there a rent, disclosing a purple-red patch of scald beneath. At last this fatal flocculence has reached the respiratory functions, and the crimson gills grow livid, surcharged with the unaërated blood, and the erst rapid breather now gasps at intervals in spasmodic agony, and in a spasm expires. The jet optic set in a ring of gold seems to look at me with some dumb utterance, as if asking the unanswerable wherefore? And there comes that esoteric whisper through the ages—the whole creation groaneth, waiting for the manifestation.

Occupants of the aquarium: *Enneacanthus simulans*, spotted sun-fish. *Mesogonistius chætodon*, black-banded sun-fish. *Lepomis gibbosus*, common sun-fish or pumpkin seed. *Carassius auratus*, crucian carp, both the gold and the silver varieties. *Melanura pygmæa*, Eastern mud-fish. *Amiurus catus*, horn pout, small catfish. *Erimyzon susetta*, chub sucker, mullet. *Aphododerus sayanus*, pirate perch. *Catostomus communis*, white sucker. *Hybognathus argyritis*, silvery minnow. *Notemigonus chrysoleucus*, shiner. Tadpoles or larval frogs.



LOCKWOOD ON DEVŒA.

FUNGI AFFECTING FISHES.—AN AQUARIUM STUDY.

SECOND PAPER. DEVŒA.

BY SAMUEL LOCKWOOD, PH. D.

(*Read March* 21*st*, 1890.)

In July, 1867, appeared in the *American Naturalist* a paper on "The Sea Horse and its Young." The article gave my observations of a male Sea Horse, *Hippocampus heptagonus* Rafinesque. The almost eccentric habits of this grotesque little marine fish induced a strong desire for other living specimens in order to learn more about it. In the fall of 1884, after seventeen years of waiting, I obtained a fine female. It proved very interesting, but died in February of the ensuing year. In 1887, the *American Naturalist* contained my second paper on this fish under the title: "More About the Sea Horse," from

Description of Plate 24.

The figures of this plate show that while the funnel pattern prevails in *Devœa* the range in variation of the type is great.

Figs. ***1, 6, 7, 9, 10, 14, 15, 17, 19, 20, 21, 22, 35*** show this sporangiform plant or thallus, with its cap or operculum. The extremes of form of the cap appear in ***14*** and ***17***.

2, 5, 8, 12, 27, 31, 33, 45, 51, 57, swarm-spores at different stages.

3, A spore-swarm lifting off the cover of the sporangium.

49, A spore-swarm leaving the mother-cell. These are enlarged much beyond the scale of the other figures. To the left is a very large spore, suggestive of an oospore!

21, A patch of thalli, of abnormal forms. To the left of ***21,*** also in ***4, 18*** and ***28,*** are epitheloidal looking bodies, which I think are the faces of these sporangoid thalli distorted by pressure, or growth crowding.

25, 47, Show five emptied sporangia, with sharp rims, and symmetrical forms.

30, 34, Empty sporangia. The contents seem denser, hence the deeper shading. This feature is seen also in ***11, 24, 26, 39,*** and in a less degree in others.

19, Adherent spores. Too large for zoospores.

6, These doubtful mycelia show the only instance of even a dubious appearance of rootlets.

The variations of form at the aperture are interesting. Figs. ***23*** and ***46*** show a wide, flattish top of sporangium with small aperture. ***26, 48, 51,*** with conical surrounding of aperture. ***30, 34,*** neck of aperture cylindrical. ***50,*** abruptly shouldered. ***25, 47,*** lip of aperture thin, or sharp, and excurvate. ***3, 5, 54,*** incurvate lip of aperture, the typical form.

12, 58, Each with a quadrifid aperture. A very eccentric form. The figures are magnified from 700 to 900 diameters.

which let us make a short extract. Having spoken of an "intense sympathy" with the little creature, this is added:

"Alas, there was now too much ground for sympathy,—a terrible malady had begun to take hold of the poor thing. The face took on a comical aspect. On each side rose a swelling as if she had the mumps. With a hand-lens I found that these were blisters, white vesicles, and so buoyant as to annoy her by producing eccentric movements. I contrived to pierce them with a needle, and so to let out the confined gas. This gave immediate relief. But they came again, and by and by my surgery did not avail. They increased, and the buoyancy would raise it to the surface, and the little sufferer despite all help would float. And so it was on the last day of February at an early hour I found poor Hippie afloat on her beam ends and dead. I had her alive just four months."

I was much surprised at this appearance of a severe skin disease, which extended over the entire body. It seemed to me a malignant scurvy. The strange thing was the presence of those white vesicles, or blisters, which actually raised it so high that it would float on its side at the surface, making it impossible for the fish to sink. A puncture of each blister with a needle would relieve the sufferer, which at once would descend in the water. The error into which I fell is now apparent. I supposed that the fish was ailing from an internal source, such as a blood disease. I am now certain that had I used the microscope upon a scraping from the skin, the cause would have proved to be external, in fact, parasites, as with my fishes in the fresh water aquarium. But in their case the fungus could be seen as a flocculent mold. The matter on this Hippocampus could not be divined by the unaided eye. At its death, I observed that under each vesicle was a spot of effused, or extravasated blood, and so the hypothesis was docketed in memory of a scorbutic affection.

In the autumn of 1889, I was the fortunate possessor of four living female Sea Horses; I was resolved to do my very utmost to make life possible and pleasant for my new pets. But these quaint creatures are to the utmost dainty and particular. One cannot feed them as he does other fishes. Their tubular mouths take in the invisible organisms of the water; in a word their food is microscopic. So for their sole occupancy, I started three small

marine aquaria—oxydizing the water with the two algæ, the green sea lettuce, *Ulva latissima* and the red coral like *Gracilaria multipartita.* Soon the infusoria appeared, and soon after came fine crops of diatoms. My plan was to put the four fishes into one of these small aquaria, allowing them possession until I supposed their food was reduced; then I transferred them to another, and in time to the third, after which they went back to No. 1. By this routine or interchange their supply of food was sustained, the water being kept well stocked with microscopic life.

In about four months, I made what seemed to me an interesting observation. It was the fact that these little creatures had the faculty of mimicry. In respect of color, their normal hue was that of a slaty or yellowish grey. From this they could take on two extremes, becoming either almost black, or even an ashy white. This latter fact led to a deception, for noticing in one of the Hippocampi certain white spots of rather long continuance, I misinterpreted the fact—as partial, or deceptive mimicry. At length I beheld to my dismay, a white blister, with some indications of uneasiness by the fish. It recalled the experience of two years before. The vesicle was at once pricked with a needle—but the malady spread over the body, when it soon died.

As I was then in the midst of my study of *Saprolegnia*, I lost no time in getting an almost invisible scraping of the skin under the microscope, when lo! my scorbutic hypothesis "went up" leaving me with another fungus of a singular character on my hands. In size the new plant compared with the *Saprolegnia* was as the little fern to the sturdy pine under whose shade it has grown.

I found some difficulty in the study of this object due to its extreme minuteness, and the crystalizing of the salt in the seawater which would proceed in each mount, thus burying or breaking up the plant. It became necessary to wash away the salt, to the cruel cost of a sad waste of material, and a pitiful destruction of the natural grouping. With these disadvantages, after a number of trials some success was achieved in eliminating the salt, and some fair mounts were made in carbolated glycerine.

In a few days another fish died, and in about three weeks all

were dead. I was hampered with the smallness of the specimens, and the extreme limitation of material, and the fact that I did not succeed in getting a growing slide. As to the size and transparency of these fungi, it was observable that though the fish for a while before and after death were ashen white wherever the fungus had attacked, yet upon being dried, the natural dark color of the skin returned, and the fungus seemed to have gone off in the air.

Mounted specimens were sent to several eminent fungologists, two of whom, to my surprise, ventured the guess that they were allied to the *Saprolegniæ.* This surmise could only come from the fact of similarity of habitat. A mount was sent to the distinguished specialist, Dr. M. C. Cooke, who wrote that he failed to find the specimen on the slide ; which was to me quite a disappointment.

Speaking generally these minute plants are funnel-formed, though the short quasi-stem ends in an imperforate point. Hence a friend on viewing them in the microscope called them little cornucopias. But these tiny wine-glasses with no bottoms or supports, how are they to stand up? A funnel or cornucopia could be made to stand erect, if the bottom were stuck in the ground. It really seems that it is the way this fungus secures attachment by the imperforate point or end penetrating the epidermis of the fish. As these are so close together their upper parts, when a patch is put in the microscope, present the appearance of a plane of scales, instead of the cottony flocci of the *Saprolegniæ;* sometimes these little cups are so crowded or squeezed that instead of presenting to the eye looking down the instrument upon them a plane of circles, they have the aspect of polygonals.

As to the fungus attaching itself by the point of its short stem, the little bend or curve sometimes suggestive of a hook, might perhaps, from the vast numbers in a series, serve as a multiple holdfast. But the usual economy of a fungus is an apparatus of rootlets or rhizoid mycelia. As I have been unable to detect such a holdfast may not its cup-like thallus suggest hair-like surroundings of the pointed base of the plant, each rhizoidal hair with a cup-like ending or sucker, not unlike the attachment of *Empusa muscæ*, the fly fungus on the window pane; for though

De Bary has relegated it "to the history of errors," the notion is not extinct that the aërial mold *Empusa* is but a condition of the aquatic mold *Saprolegnia*.

This cup-like plant is surmounted by a lid or operculum, very suggestive of that to the capsule of a moss. It lacks the symmetry of the latter—being sometimes a relatively short cone, and at other times quite long. The rim or edge of the cup is inflected, so that the aperture into which the lid fits is not nearly so wide as the diameter at the face. Over this opening sits the operculum, thus giving the appearance of two funnels, with their apertures facing each other, the smaller one being uppermost.

The above is the position until fructification is complete, when the sporidia become a heap, rising into the operculum or cap, and lifting it up and off. They are now a spore-swarm, and as such are quite large when compared with the size of the parent thallus, but individually they are so small that a magnification of about 900 diameters gave only limited details of structure.

It thus appears that the thallus, or entire plant is a mother-cell or capsule; in fact I believe it is a compound sporangium. I have seen numbers of these emptied capsules open or split down one side, from the aperture. These seeming rents revealed lines irregularly parallel, and lengthwise of the sporangial capsule. These are each attached by one edge to the inner wall of the capsule like the gills in the pileus of a mushroom, or any agaricoid fungus. These laminæ do not reach across the capsule; thus they form a well-like space under the opening or outlet which is covered by the cap or operculum. It seems to me that the spaces between these laminæ serve for sporific or quasi-hymeneal planes, from which the sporidia are discharged into the central part, or well of the sporangial capsule, and thence like a little cloud they swarm as zoospores at the outlet, that is, over the edge of the cup-like mother-cell.

As noted in our first paper a distinguishing trait of the *Saprolegniæ*, is the issuance from the sporangium of the zoospores, or motile spores. It seems to me that these swarms of this marine fungus must consist of motile sporidia. But on two points we need light—the history of the spore development or complete fruition—and assured knowledge in respect to the absence or presence of

the rootlets or rhizoid mycelia. On this point it may be remarked, that the necessity for these rootlets is not the same in the Hippocampi, and the percoid fishes. In these latter the scales are very thin plates, lapping upon each other shingle-wise; hence, easy for the mycelia to creep under. But the scales of the sea-horse are not unlike those of the sturgeon—rising to a point at the middle like the boss in a shield. They do not lap on one another, but so to speak, are soldered to the epidermis. Hence, there are spaces of naked skin between these plates, and on them the fungus finds place for attachment.

I think then of this marine fungus, enough has been observed to afford marks for differentiation, and determination from all others. Thus I will attempt a definition of this new genus, and new species. Its habitat on fishes, at once suggests the *Saprolegniæ* as its family relation. A striking *difference* appears in the form of the thallus. The entire plant seems to be a cup-like, or funnel-shaped capsule, with a hood, or cap-like operculum; and the impossibility to differentiate the thallus or plant into hyphæ and mycelia.

But functional features are more important than morphological, or perhaps it is better to say—in respect of our plant, its physiology is more significant than its anatomy. And in this view I find marked family traits or *resemblances.*

1. The spores are endogenous, being produced in a mother-cell, or sporangium with no other organic impact.

2. These spores when ripe attain for a short time, a few seconds at most, a self-assertive force, when by individual and collective enlargement or swelling, they raise and push or lift off the hood which caps the sporangium.

3. These sporidia are self-moving bodies, and their motile force is not derived from any immediate communicative impact or descent. Hence with reference to this mysterious vitality they are well called zoospores, while with regard to their rushing movements at the instant of escape from the sporangium, they are called motile or swarm-spores.

4. At this stage these motile spores are hardly worthy the name of cells. If there is at all an outer and inclosing membrane no lens has shown it, hence it can be no more I think than the film of the dew-drop. Their appearance is that of

irregular roundish masses of cohesive granuloid protoplasm. Some vacuoles seem discernible, but beyond this my $\frac{1}{12}$ water immersion with B eye-piece failed to go, not even revealing the usual propelling ciliæ. Yet we must suppose the existence of the latter, with also the central neucleus, imbued with that force necessary to the coming phenomena of life.

5. If we add that in common with the *Saprolegniæ* their home is aquatic, their habitat as parasites is the fish, and their mission to weave like Dejanira a toxic shroud of suffering and death upon the living, the resemblance to *Saprolegnia* is in some particulars quite striking.

I feel that without the special knowledge of the fungologist, and the algologist, it becomes one to be modest in the matter of speculation. Yet it may not be presumptuous in this connection to say that our new fungus has impressed me with the conviction that the believers in a border land for these aquatic molds between the fungi and the algæ may not be visionary after all.

Regarding our fungus as a novelty, it should be christened in due form, for before it can go into scientific registration, it must receive a canonical description.

Thallus, an infundibuloid capsule, or sporangial cell, the basal end, an imperforate point, often a little curved, constricted or inflected at the rim, making the aperture about $\frac{1}{5}$ that of the diameter across the face. Fitting to this a membraneous cap or operculum, very variable in length, and form of the posterior part. Inside the capsule a hollow-core of somewhat wavy or irregular parallel planes, their inner edges making a well in the middle of the capsule. The sporidia from these hymeneal lamellæ issuing into the well, there swelling, the mass rising lifts off the operculate lid, flows over the rim, and thus swarms from the mother-cell. Neither hypha nor mycelium observed. History of the spore development unknown. Habitat-Parasitic on the marine fish, *Hippocampus heptagonus* Rafin.

As esteeming the scientific zeal of a member of our society, the species is named, *Devœa infundibilis* Lockwood.

Note.—Prof. Bashford Dean suggests the question: "How much may any injury to a fish, such as removes the external mucus, have to do with its susceptibility to the fungus?" As perhaps bearing on this let me mention that the egg of a Nereid must have been in the water when I improvised my little aquarium for the Hippies. It attained a growth of three inches in length, and was not hurt by the fungus. The Nereids are smooth, and burrow in the sand, and their many joints or sections afford easy places for the fungus to attach themselves.

INAUGURAL ADDRESS OF THE PRESIDENT,

P. H. DUDLEY, C. E.

(*Delivered January 17th*, 1890.)

In the selection of your presiding officer, I am deeply sensible of the honor conferred, and not unmindful of the responsibilities implied. The Society has now entered upon the thirteenth year of its corporate existence, showing even in this busy city, the commercial metropolis of the country, that there is a necessity and demand for such a society as this. By its support and constant growth the wisdom of its incorporators has been shown. As members of the Society it is not only our duty, but also our pleasure, to take up the work they so well began and carry it on with a will, so that the society interests may be duly enhanced

The evidences of material prosperity are before you.

1. Ten fine microscope stands.

2. A cabinet of slides containing many valuable and rare specimens.

3. A library containing the current publications of interest to the Society.

4. And last, but not least, the publication of a Quarterly Journal of the proceedings of the Society, which goes to all parts of the civilized world. This last feature I believe is not enjoyed by any similar society in the United States. These are substantial facts in which each one can take a just pride and feel honored by being a member.

The building up and maintaining the work of the Society cannot be best done by a few individuals, no matter how important their contributions may be, but by the combined work of all its individual members. It is not necessary, nor is it expected, that all devote their energies to the same branch ; but that each work in that which is of special interest to him. One of the important advantages of the Society is that members can bring their special work before a body where it will be appreciated, and in return receive that sympathetic stimulus which encourages them to greater efforts. On the other hand, members who are not working in that special field gather in a few mo-

ments the results which have taken perhaps weeks and months to ascertain. The workers and hearers are mutually benefited.

Whether the microscope is used as an instrument purely for scientific research, or for seeing the beauties of organized structures, it develops and broadens the conception of the mind, aiding one to understand and take advantage of many of the laws which control matter. As stated in the admirable address of our retiring President at the last meeting, the French savant, Louis Pasteur, by his studies on Fermentation with the microscope, ascertained the laws which governed it. He found that it was due to the growth of definite organisms in every case, and not due to spontaneous generation. Knowing the laws of the growth of those organisms, he could produce fermentation, or check it at his pleasure. This simple truth which remained hidden for centuries is one of the grandest yet revealed by the microscope. Its discovery at once led to the use of antiseptic measures in surgery, and thousands of lives have been saved thereby. Koch soon took up the principle, enlarged its application, and discovered the bacillus of Asiatic Cholera, thus materially reducing the dread of that disease. The laws of the growth of this microbe are now so well known that the spread of the disease can be easily checked and stamped out.

The use of the microscope in studying the sources of contamination in the water supplies of our large cities is hardly less important. In nearly every department of applied science the microscope forms one of the necessary instruments of research, and its use is being daily extended. The use of the microscope in the mechanical arts, as an instrument of precision to determine definite lengths and sizes, and the ability to duplicate them in quantities, is an application so important that it will soon exert a reflex influence in the improvement of the microscope itself. The mention of only a few of the important uses of the microscope is alone sufficient to show its great value to mankind, and that it is highly creditable to foster its use and disseminate the truths gained thereby.

In taking up the duties of the position, I invite, and feel confident that I shall receive, the earnest and hearty co-operation of the officers and individual members in furthering the interests of the Society.

NOTES ON STAINING SECTIONS MADE BY THE PARAFFIN-PROCESS ENCLOSED IN A FILM OF COLLODION.

[Abstract and translation from an article by Prof. H. Strasser, in *Zeitschrift für wissenschaftliche Mikroscopie*, vi., 150 (1889).]

BY LUDWIG RIEDERER.

(*Read April 18th*, 1890.)

Having reported, at the meeting of this Society, held December 6th, 1889 (see JOURNAL, vi., 56), 1st, on enclosing sections in a film of collodion, and 2d, on placing them on provisory supports, I desire now to give an abstract, 3d, on the method of the subsequent staining of such sections, in case the object has not been stained before. As this treatment permits the use of different staining fluids on the same series of sections, its value is obvious.

The successive steps of this method of staining are as follows:—

a. Fixing the paraffin-embedded sections in collodion.

b. Hardening the collodion to a film by turpentine.

c. Removing the film to aqueous or aqueous-alcoholic solutions.

d. Bringing it back to turpentine.

e. Enclosing the sections on provisory supports for preserving, or for mounting on slides.

a. As a support for the collodion-film containing the sections during the whole time that the treatment lasts, no more paraffined or waxed paper is used, but gummed paper.

Thin, well-sized paper, of smooth surface, is caused to receive on one side a coat of a thick solution of gum-arabic in water, containing 10 per cent. (by volume) of glycerine. A mucilage of this composition will dry completely, and the film produced will have no cracks and will be flexible. On this support the sections are secured in collodion, as stated in the first paper, by the use of a solution of collodion, No. 1, containing two parts of collodion and one part of castor-oil, and covered by solution, No. 2, containing equal parts of collodion and castor-oil. It is necessary, however, to give a supporting plane to the collodion-film, on which it will remain stretched, as if on a drawing-board,

during all the following processes. This prevents all rolling or folding, as well as the shrivelling of the film, when coming successively in contact with liquids of different specific gravity and of different chemical qualities. To smooth a folded or rolled film is sometimes very tedious, but to remove wrinkles, caused by shrivelling, is impossible.

Whenever the film of gum-arabic comes in contact with water, it is dissolved, and the paper support and the film of collodion are separated. This premature separation can be prevented in different ways. One way is to leave outside of the space intended for the sections a margin free from mucilage. If the solution of collodion is brushed over this ungummed paper, the collodion will soak the paper and stick fast to it. Another way is to fasten and cover the sections in the manner described, but, before the immersion in turpentine, a dented wheel, such as is used for tracing patterns, is run along a line outside of the space containing the sections. Through the holes thus made the collodion comes in contact with the paper below the gummed surface and sticks to it. As soon as the treatment is finished, collodion-film and paper-support can easily be separated from each other, in either of the described methods, by cutting away the lines of margin where collodion and paper stick together.

b. The hardening of the collodion in the bath of turpentine takes place on removing the alcohol, ether and castor-oil, these being dissolved by the turpentine. For the purpose of doing this, as thoroughly as possible, a second bath of fresh turpentine is to be used. If work is continued, the liquid of the second bath can be used later as the first one. Warming the baths slightly will shorten the time required for the removal of the films from the liquids.

c. First, the surplus of turpentine is now allowed to drain off, then the support with the film is put between thick layers of filtering paper. This is repeatedly renewed, and the whole is subjected to a constant pressure for some time. The sections are not likely to be damaged by this pressure, if the collodion-film is not too thick, and has before been sufficiently hardened. Now a bath of equal parts by weight of chloroform and 95 per cent. alcohol is employed from one-quarter to one-half of an hour, to remove the last traces of turpentine. If then transferred

to alcohol of 80 per cent. both film and support will be moistened by it. This fact will prove that the turpentine has been successfully removed. In this alcohol of 80 per cent. the sections may be preserved for any length of time.

To proceed, a bath of 10 per cent. alcohol follows until the film is thoroughly soaked. After this is done sections and film moisten, when in contact with aqueous solutions, and the sections can be stained by the proper staining fluids. When it is possible, however, it is advisable to add a small quantity of alcohol, as a small percentage of this in staining fluids greatly increases their penetrating power.

In case two different liquids—one as a mordant—are to be used to produce the staining, it is necessary to employ the mordant on the whole object before the embedding process, because in this way the collodion and paper are not stained, but only the sections. Over-staining is reduced in the usual way.

d. For the purpose of transferring the film and support to turpentine again, it is necessary only to dry both superficially between filtering papers and then to immerse them in creosote, oil of origanum or liquified carbolic acid (1 to 3 xylol, according to Weigert) ; or, better, to bring them first to alcohol of 80 per cent., before employing these liquids. Then lay this support—film underneath—on filtering paper soaked with creosote, and, after film and sections are made transparent, transfer to turpentine.

e. Finally, the borders or lines of perforations made by the dented wheel are cut off, film and support—film underneath—are laid on thin paper, on which is a coat of rosin and turpentine. Air-bubbles between paper and film must be avoided, and the paper, which has so far formed the support is pulled off. A coat of rosin in turpentine is applied to the now exposed lower side of the film, and another thin paper laid flat on this. Turpentine penetrating the thin paper must be blotted off.

Instead of enclosing thus in rosin and a provisory support, the film with the sections may be mounted on slides in the usual way. Numbers or notes, to be enclosed at the same time with the sections in the collodion-film, should be written on thin paper with a soft lead-pencil, or with india-ink.

PROCEEDINGS.

Meeting of February 7th, 1890.

Owing to alterations in progress at the rooms of the Society, the meeting was held in the Natural History Hall of the College of the City of New York.

The Vice-President, Mr. J. D. Hyatt, in the chair.

Forty-five persons present.

Dr. William Stratford addressed the Society on "Methods in Photomicrography." This address was illustrated by a series of photomicrographic apparatus, and by a series of lantern slides showing stages of nettle-cells of *Physalia*; living diatoms, mainly *Heliopelta* and *Triceratia*; diatoms in stages of reproduction; and injured frustules of diatoms. Perhaps the most beautiful exhibit of the collection was a *Suriella gemma*, taken under a Powell and Lealand 1/4, with oblique light from the prism, in the green band of the spectrum, showing most prominently the difficult "basket work."

Mr. L. Riederer read a Paper, entitled :—"The Ovipositor of *Cryptus samiæ*."

OBJECTS EXHIBITED.

1. Transverse section of ovipositor of the ichneumon fly, *Cryptus samiæ*: by L. Riederer.

2. A photomicrograph of *Pleurosigma angulatum*, × 4900, recently received from Zeiss: by P. H. Dudley.

Meeting of February 21st, 1890.

The President, Mr. P. H. Dudley, in the chair.

Sixteen persons present.

President Dudley read a Paper upon the Termites of the Isthmus of Panama, referring especially to the genus *Calotermes*. The Paper was illustrated by numerous specimens of different species, portions of nests, and destructive wood-borings, together with microscopic slides and photographs of nests, sent by Mr. J. Beaumont, of Colon, S. A. Mr. L. Riederer exhibited sections of Queens of Termites in connection with the above Paper.

Mr. Dudley was requested to repeat this Paper, with the illustrating exhibits at a subsequent meeting of the Society.

Dr. Paul Hoffman made some interesting remarks upon the "white-ants" of India.

Dr. Frank D. Skeel exhibited photomicrographs of sections of chalcedony and silicified wood, taken by lamp-light with an inch objective of his own grinding, and showed some prominent structural characters, photographed by polarized light. The mineral sections from which the photographs were taken, were ground by Mr. J. D. Hyatt.

Meeting of March 7th, 1890.

The President, Mr. P. H. Dudley, in the chair.

Twenty-one persons present.

Dr. Samuel Lockwood read a Paper, entitled "Fungi Affecting Fishes. An Aquarium Study. First Paper—*Saprolegnia.*" This Paper is published in the present number of the Journal, p. 67.

The subject was also discussed by Messrs. Dean, Hoffman, Leggett and others.

Meeting of March 21st, 1890.

The President, Mr. P. H. Dudley, in the chair.

Twenty-five persons present.

Mr. Charles S. Shultz announced the death of Mr. Samuel Wilde, a Member of the Society.

Dr. Samuel Lockwood read a Paper, entitled "Fungi Affecting Fishes. An Aquarium Study. Second Paper—*Devæa.*" This Paper was illustrated by numerous microscopical preparations, and is published in the present number of the Journal, p. 79.

OBJECTS EXHIBITED.

1. Wood-sections, prepared by Mr. Romeyn B. Hough: by Charles S. Shultz.

2. Diatoms, 384 forms from the "New Santa Monica Find," prepared by Möller: by E. A. Schultze.

3. The Koch and Woltz microscopical lamp: by Geo. E. F. Haas.

Mr. Haas discussed with several members of the Society some of the merits and defects of the operation of the bent glass rods of this lamp.

Meeting of April 4th, 1890.

The President, Mr. P. H. Dudley, in the chair.

Twenty-seven persons present.

Mr. William G. De Witt, of the Committee on Purchase of Objectives, reported that six low-power objectives had been purchased for the use of the Society.

The Corresponding Secretary read a communication from the University of Toronto, requesting the donation of publications for the refurnishing of the library of the University, lately destroyed by fire.

On motion of Mr. Charles F. Cox, the Publication Committee was instructed to donate to the University of Toronto, a complete set of the publications of the Society.

President Dudley, at the request of the Society, repeated his Paper of February 21st, 1890, on "The Termites of the Isthmus of Panama." Mr. Dudley introduced some recent work of Mr. J. Beaumont, of Colon, S. A., in connection with this subject, and illustrated his Paper by a full collection of the insects, and of specimens showing their operations. After the reading of the Paper, numerous lantern projections were thrown upon the screen, consisting of many photographic views taken from a train while in motion across the Isthmus, and also of many microscopical mounts of the Termites, prepared by Mr. L. Riederer, as announced below.

OBJECTS EXHIBITED.

1–9. Nympha of *Termes minimus.* First form, showing nine progressive states in the development continuously to the imago.

10–12. Nympha of *Termes minimus.* Second, or supplementary form. Showing three progressive states as above, the wing-pads remaining rudimentary.

13. Wing-pads of nympha of *Eutermes.*

14. Wing-stumps of young queen of *Eutermes.*

15. Rudimentary wings of supplementary queen of *Termes minimus.*

16. Serial, sagittal sections of abdomen of male *Termes testaceous.*

17. Serial, sagittal sections of abdomen of male *Eutermes* (*Termes miles nasutus*).

18. Transverse sections of abdomen of full grown queen of *Eutermes.*

19. Sagittal sections of abdomen of young queen of *Termes miles nasutus.*

20. Sagittal sections of abdomen of young queen of *Termes*, sp.

Dr. Edw. G. Love also exhibited twenty-five photomicrographs, mainly of crystals and vegetable tissues, taken by polarized light. Dr. Love stated that he had made many negatives with the use of polarized light ; that it frequently brings out details which cannot be discerned by ordinary light ; and that the method was well adapted to vegetable structures, such as starch-grains, wood-sections, &c. The subject was also discussed by Messrs. Dean, Cox and Dr. Skeel.

PUBLICATIONS RECEIVED.

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The Microscopical Bulletin and Science News : Vol. VIII., No. 2 (April, 1890).

The Natural Science Association of Staten Island, Proceedings : (March 13–May 8, 1890).

The San Francisco Microscopical Society, Proceedings : (February 26–April 23, 1890).

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The Botanical Gazette : Vol. XV., Nos. 2–5 (February–May, 1890).

Psyche : Vol. IV., Nos. 138–140—Vol. V., Nos. 167–169 (October, 1889–May, 1890). Index to Vol. IV.

Entomologica Americana : Vol. VI., Nos. 4–6 (April–June, 1890).

Insect Life : Vol. II., Nos. 9, 10 (March, April, 1890).

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Indiana Medical Journal: Vol. VIII., Nos. 9–11 (March–May, 1890).

The Satellite: Vol. III., Nos. 7, 8 (March, April, 1890).

The Hahnemannian Monthly: Vol. XXV., Nos. 4–6 (April–June, 1890).

Johns Hopkins University Circulars: Vol. IX., Nos. 80, 81 (April, May, 1890).

The American Lancet: Vol. XIV., Nos. 3–5 (March–May, 1890).

The Pacific Record of Medicine and Surgery: Vol. IV., Nos. 8–10 (March–May, 1890).

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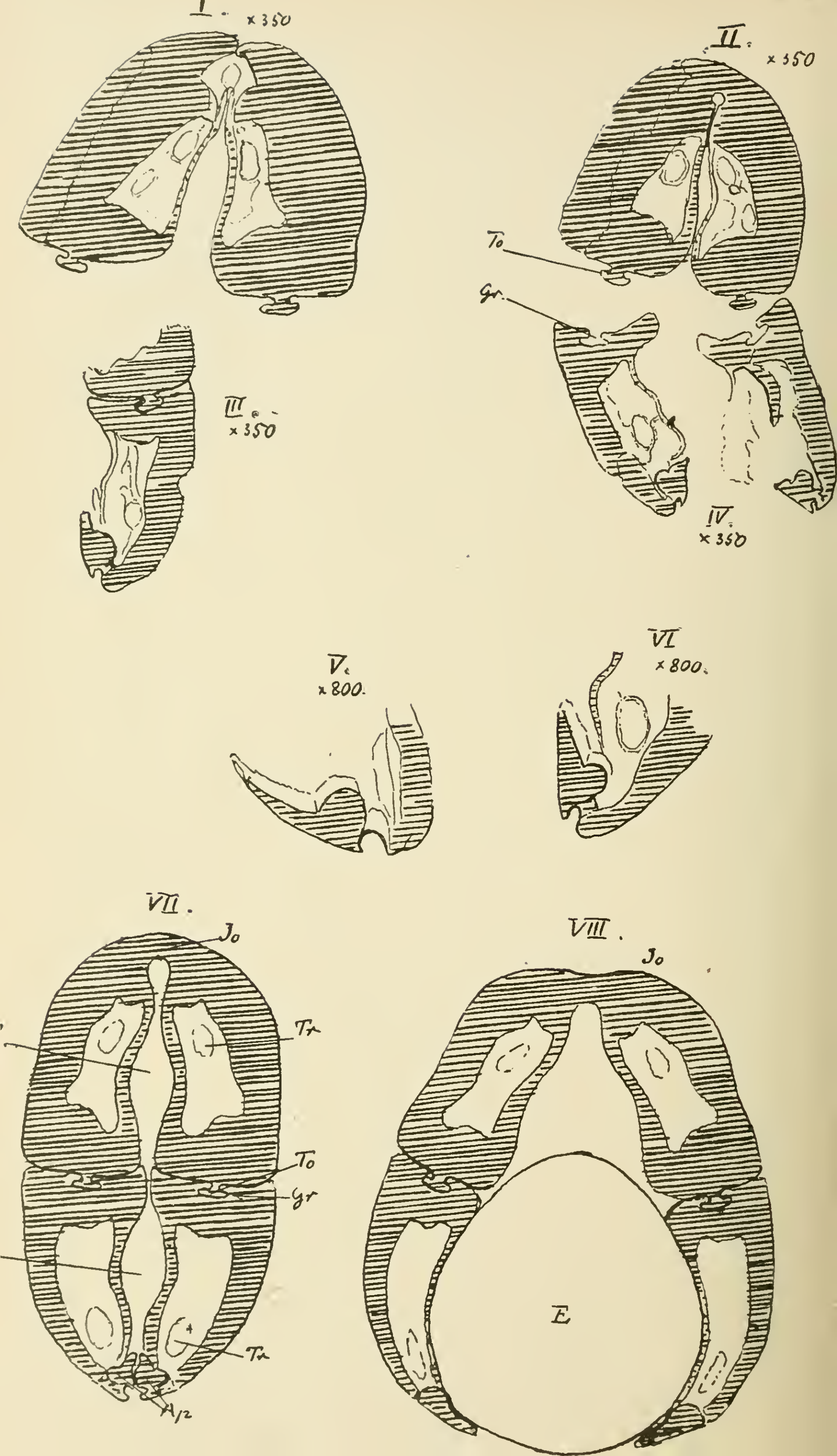
PLATE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JOURNAL

OF THE

NEW-YORK MICROSCOPICAL SOCIETY.

VOL. VI. OCTOBER, 1890. No. 4.

THE OVIPOSITOR OF CRYPTUS SAMIÆ PACK.

BY LUDWIG RIEDERER.

(*Read February 7th*, 1890.)

The members of this genus of hymenopterous parasites are conspicuous on account of the length of the exserted ovipositor. This latter is composed of the ovipositor proper, and the two enclosing sheaths. These originate from the end of the abdomen, while the ovipositor proper protrudes from the ventral line of the abdomen, behind the sixth ring. The oviduct reaches this place in a forward direction, and there connects with the ovipositor, where it makes a bend downward and backward. As a consequence the thence straightening tube reaches far behind the body of the insect. Several bundles of muscles run from the point of exit of the ovipositor, in both an upward and backward direction, the latter bundles extending towards the anal end of the abdomen. The ovipositor proper is formed by one dorsal and two ventral parts, and they are fastened together in such manner that they can slide up and down upon each other, as far as the corresponding muscles in the abdomen will allow, but the parts cannot be separated sidewise.

Description of Plate 25.

I., II.—Dorsal parts, × 350.

III., IV.—Ventral parts, × 350. The combination of the tubes gives the greatest strength for the least material employed. The substance of the tubes is thickest on the sides of the surface, and near the tongues and grooves, and it is thinnest and most flexible on the sides which form the vertical slit. The soft substance and tracheæ are seen in the tube.

V., VI.—Appendices to ventral parts, connected by elastic joints, × 800. Figs. I.-VI. are drawn with the camera.

VII., VIII.—Diagrams to show the ovipositor while closed, and also while extended by the passing of the egg. Jo, Joint of dorsal part. Sl, Slit, forming passage for the egg. Tr, Tracheæ enclosed with soft substance in the tubes. To, Tongues. gr, Grooves. Ap, Appendices on the ventral parts. E, Egg.

When searching for information about the shape of the constituent parts, I could find only a few descriptions and sketches, and all of them were so indefinite that it was evident they were made more by employment of imagination than of actual observation. It is therefore interesting to study the shape of these parts, and their working together for their intended purpose. By means of the microscope we can see that the parts are barbed in different ways, as I showed at the meeting of January 4th, 1889. But, besides several lighter and darker shaded lines, we cannot find out much that is instructive about the form of the interior. The preparation of cross-sections does not furnish very promising results, because chitine—the main substance of the ovipositor—is so hard and brittle that out of a considerable number of sections sometimes none will show enough for an explanation. As the imago of the insect gave so little hope for success, I tried different states of development of the pupa, up to the time when the imago is just emerging, and this last state gave the best results.

The chitine skeleton of insects develops to the proper shape while the insect lies dormant as a pupa, and is still soft when the imago emerges, but hardens in a few hours, when out of the pupal skin. I had on hand a few cocoons of the large moth, *Platysamia cecropia*, infested with a brood of *Cryptus samiæ Pack.*, belonging to the family Ichneumonidæ, and thus I succeeded in procuring the different states of development. This insect gives the following approximate measurements: length of head, thorax and abdomen, 10 mm.; expanse of wings, 16 mm.; length of antennæ, 5 mm.; length of ovipositor, 6 mm.; diameter of the same, 0.2×0.1 mm.

The ovipositor, on the cross-section, shows that it is composed of four tubes, which are so compressed as to give an oval shape. The four tubes are all separated from each other, excepting the two dorsal ones. These are fastened together along the dorsal line into one single piece. At the line of contact between the dorsal and the ventral parts, the dorsal part has two projections or tongues, each one having the shape of the capital letter, "T." These T-shaped tongues are fitted into grooves of the same shape in the ventral parts. By this arrangement the dorsal and the two ventral parts can slide alongside of each other, as far as the muscles inside the abdomen will allow; but, by the same

arrangement, they are prevented from separating laterally. As the two dorsal parts are fastened together in one piece only along a fine line on the surface, this allows the two parts to be separated from each other for a certain distance, like the two sides of a hinge. Yet as soon as any force ceases to separate them, the elasticity of the joint will bring together again the two sides of the ovipositor. The passage of the egg from the oviduct into the slit, formed by the two sides of the ovipositor, tends to separate these parts, and at the same time, by the elasticity of these latter, the egg is firmly held in the slit. By the reciprocal movement of the sliding parts the egg is forced forwards. Yet the pressure exercised on the egg by this means is alleviated by the flexibility and thinness of the sides of the ventral parts forming the slit. Besides this the tube of the ventral parts is filled by a soft plastic substance, in which is embedded a trachea of good size, all acting like an air-cushion. Two small projections at the edges of the ventral parts prevent the egg from escaping sidewise. When not in use, these "appendices" are kept between the two ventral parts, close to their inner sides, by the elasticity of the connecting joints.

The pupa shows five wide tubes, bent around the end of the abdomen, and reaching well forward on the dorsal part of the insect. In these five tubes are contained, separate from each other, the one dorsal part, the two ventral parts, and the two sheaths. The less the development of the pupa has progressed, the less is visible of the finer structure of the single parts. The parts representing the tubes of the future ovipositor proper are homogeneous, showing no, or, later on, but slight differentiation. In the dorsal part no slit is visible, and but a trace of the projecting tongues, and the grooves in the ventral parts do not yet appear. Thus the union of the one dorsal and the two ventral parts of the pupa, into the ovipositor of the imago, takes place at the time when the mature insect bursts open the pupal skin, and forces its way out. Then the soft tongues enter the grooves, and the parts assume their proper shape and hardness. In this manner, it seems to me, takes place the formation of the ovipositor, a complex organ, composed of the formerly separated single parts.

THE TERMITES OF THE ISTHMUS OF PANAMA.

BY P H. DUDLEY, C. E.

(*Read April 4th*, 1890.)

In the previous paper on "Termites from the Isthmus of Panama," it will be remembered I stated three genera had been identified by Dr. Hagen, viz.: *Termes*, *Eutermes* and *Calotermes;* the first being represented by five (5) species, the second by three (3) species and the third by only one species. With one exception, the injury and destructive work to buildings, wood-work, cars, locomotive cabs, and furniture, had been done by species of the *Termes* and *Eutermes*. The exception was the injured portions of a first-class coach in daily service, attacked by *Calotermes marginipennis Latrielle*, as identified by Dr. Hagen. This species is found in Mexico, Central America, and California, though possibly not a native of that State. It is now known that they are frequently transported from one country to another, in trunk frames and wooden utensils.

During the past year a number of species of *Calotermes* have been found upon the Isthmus, and much more is now known of their habits in that locality. With the exceptions of their great destructiveness to sound wood-work, and rapid increase in numbers, they materially differ from either of the other two genera.

The *Calotermes* on the Isthmus do not have a distinct class of members, known as workers, and, in the large communities, only a small percentage of soldiers have been found.

No evidence of the *Calotermes* constructing large nests or galleries on the exterior surfaces of wood-work, trees, or even buildings, has so far been found upon the Isthmus. After entering a piece of wood-work or furniture. through a small crevice of a joint, or by boring an orifice from an adjacent piece of wood, they eat out the interior, in small pockets, entering each by a small orifice on the side, only sufficient to admit one insect at a time. Mr. Beaumont thinks, there being no extensive galleries, the small amount of guard-duty required, explains in a measure why there are so few soldiers. They are the only blind members in the community, and, being wingless, they do not swarm.

Only small queens of the genus *Calotermes* have been obtained upon the Isthmus, but there are great numbers of them

in the large communities, and the increase in numbers is very rapid. In the seat-rails in the coaches, which were destroyed by *Calotermes marginipennis Latrielle*, Mr. Beaumont estimated that nearly one-half of the number of the insects was females.

The *Calotermes* are dangerous pests, from their secluded habits. And, with one exception, they scarcely give any indication that they are in wood-work of buildings, coaches or furniture. The exception is the presence of little pellets of partially digested wood, about $\frac{1}{50}$ of an inch long, and $\frac{1}{100}$ of an inch in diameter. These are found upon the floor. In eating out the pockets in the wood they are careful to leave a thin partition between adjoining pockets. This is undoubtedly due to the instinct of danger from breaking through a surface I have one pocket which probably was one of the first constructed in the wood, and subsequently the wood surrounding it was eaten, leaving it intact, its support being derived from the tube, which was formed by leaving the wood containing the orifice or entrance to the pocket. No evidence has been found of the *Calotermes* repacking the excavated wood with solid material, making it into nests, as is the case with the *Termes*.

Sometimes a pocket will be found partially filled with the loose pellets before mentioned, but the majority are empty.

Because the *Calotermes* have no workers, in the sense of the other genera, I do not wish to convey the impression that they are idlers. On the other hand, they are very aggressive and voracious, eating hard, sound woods, which the other genera are not as liable to do. From the fact that the hard, sound wood wears away their mandibles, I am induced to think that naturally they live on soft wood or that undergoing decay.

In a recent communication I partly explained the reason of their ability to eat hard woods, notwithstanding the fact that the wood wears off the cutting portions of their mandibles, *i. e.*, the anterior teeth by which they sever the wood from the block. So far as now observed by Mr. Beaumont, and judging by the specimens of insects of the *Calotermes* sent to me, a large percentage of a community is composed of larvæ and nymphæ. A nympha will undergo several moultings before reaching the imago state, and at each moult will be provided with a new set of mandibles, replacing the older worn ones, and the wood cutting goes on with little interruption. When the mandibles of the imago

are worn, it is fed. Slide No. 32 shows the position of the mandibles for cutting wood. Mastication of the chip is performed by the posterior dentition. Slide No. 4 shows the worn mandibles.

Mr. Beaumont had several young *Calotermes* queens in white ash blocks for observation under his microscope, and saw them frequently cut a chip from the block. When the queen's mandibles became so worn that she could not do so, then she would starve. If, however, nymphæ were put in the block, which could cut the wood and feed the queen, then she would thrive. Mr. Beaumont's ash blocks are 3¼ inches long by 1¼ inches square, on the upper side of which he grooves to receive a glass slide. Under the slide he cuts small V-shaped grooves into which he places a few living members of different species, and then covers them with the glass slide. In this way he could put the blocks under the microscope and observe the insects, and he learned more of their habits than could have been done in any other way. In many of these blocks he had pairs of several different species of Termites with two or three eggs, and as many larvæ.

Before mentioning some of these observations, I will describe how he obtained the little colonies he placed in his blocks, as it illustrates an interesting phase in the life-history of the Termites, and is common to the three genera upon the Isthmus. On the beach at Colon, in Coral avenue, near his house, and the shops of the Panama Railroad, stands a large Coccoloba, or sea-grape tree. It is really a tree of refuge for insects. I have two photographs of the tree taken from opposite sides. It will be noticed the tree is inclined, due to the constant direction of the trade-winds during the dry season, corresponding to our winter and spring. The bark of the Coccoloba is rough, thick and comparatively soft. The older layers are easily penetrated by insects. Mr. Beaumont says larvæ of a species of saw-fly bore into the bark, forming a small pocket, which is soon vacated. The entire life-history of this fly is shown in a series of vials with exhibit No. 26.

In the vacant pockets a pair of Termites finds a hiding place. Species of all genera upon the Isthmus have been found in the bark, all within the space of a few inches square. Each is, however, entirely distinct, without any connection one with the other.

Finding these little pockets occupied with pairs of Termites, Mr. Beaumont cut out portions of the bark, containing pockets and little colonies, and transferred them to recesses prepared in his ash blocks. The first pair transferred had two larvæ and seven eggs. Some of these eggs hatched, one producing the larva of a *nasuti* soldier, and others the larvæ of workers. These continued to thrive for four or five months, but they did not like the light, or their doings investigated, and tunneled under the bark, keeping out of sight. As long as they could be observed, the queen cared for the larvæ at first, but as soon as the larvæ workers were a few days old they also assisted. One or two moultings occurred, which occupied about one hour of time. This was much shorter than the observed time for transformations of the *Calotermes*. The queens found in these pockets are very small, but little larger than when they swarm and lose their wings. Making sections of the queens in this stage eight to ten nearly mature eggs are found. But little development, however, has taken place in the ovarian tubes beyond the nearly mature eggs. This feature has been noticed by others, when making dissections of the young queens after swarming. The true explanation of this is yet to be ascertained. Several pairs of *Calotermes* were transferred from the Coccoloba tree to the ash blocks. They did not object to the light, and their movements and actions were readily studied.

One pocket contained a pair and three eggs. Mr. Beaumont had the pleasure of seeing a larva emerge from the egg, and in an hour or two saw it take its first supply of food, while observing it under the microscope.

The larva, crawling to the posterior of the queen's abdomen, touched it with its antennæ, opened its mouth and received a supply of some fluid food. This statement only applies to the *Calotermes;* feeding of the larvæ of the other genera, has not been reported by Mr. Beaumont.

The little pellets of partially digested wood are also used as food by the *Calotermes*, being fed to the imago with worn mandibles, and to the youngest nymphæ as now observed. Mr. Beaumont finds when a queen and larva are placed in one of his ash blocks, the larva flourishes as long as the queen can cut the food from the block. But when her mandibles become so worn that she can not do so the larva dies, and eventually the queen.

Mr. Beaumont found in the Coccoloba tree a small colony of *Calotermes*, the soldier of which is like the one figured by Dr. Hagen as *Calotermes flavicollis*. The largest of these soldiers was ¾ of an inch long, and was armed with powerful mandibles. Several more soldiers from the same nest were over ½ of an inch long, and had the appearance of not being fully grown. These are by far the largest soldiers from the Isthmus so far discovered, and are shown as specimens No. 5.

No large colonies of the same species have been found upon the Isthmus, though they may exist. *C. flavicollis* is not known to have been found in Central, South, or North America, but is in Spain, Italy and Egypt. A large amount of the plant used in the excavation of the Suez Canal went to the Isthmus, and it is possible, *Calotermes flavicollis* was in the timber portions of the plant.

It will be remembered that I stated that in the communities of the *Termes* and *Eutermes*, beside a queen, or queens and kings, their were soldiers and workers, the latter being many times the most numerous. Of young there would be larvæ and nymphæ of several ages, many of the latter with long wing-cases developing into winged imagines, both male and female, previous to the swarming season. The winged imagines all have eyes, and swarm, while the soldiers and workers are blind, and do not swarm. The soldiers do guard-duty and defend the community against minor attacks, though, when the community is attacked in great numbers, the workers assist in the defence. Mr. Beaumont watching *Termes testaceus* swarm, from a nest in a yellow pine sill, said the soldiers surrounded the orifice from which the insects issued, and stood guard with their mandibles open.* Upon the workers devolves all the labor of nest building, construction of the extensive systems of galleries, tunnelling the wood, rearing the young, and caring for the queens.

Mr. Beaumont, who has watched several species of the *Termes* and *Eutermes* in his glass termitaria, says the work is done in a very orderly, and systematic manner.

The soldiers of the *Termes* have long sickle-shaped mandibles, operated by powerful muscles.

* Observations of May, 1889.

The heads of the soldiers of the *Eutermes* terminate in a long beak, containing a tube or gun, from which a glutinous shot can be thrown. This is a singular provision of nature. The smallest member of the community being provided with such an effective weapon, that at some distance one can put an antagonist even twice his size *hors de combat*, the legs and antennæ of the latter rendered useless by the quick drying viscid shot. Cuts of the heads of the *nasuti* soldiers will be found in my previous paper.

As complex as the members and habits of a *Termes* community may seem from the above; I have now a series of specimens of *Termes minimus* Beaumont, showing them to be far more complex.

These specimens have just been received from Mr. Beaumont, and are the most complete of any series known of a single species. In the genus *Termes*, besides the true queens and kings, there are supplementary queens and kings, and several stages of larvæ and nymphæ incident to the latter forms.

The fact of there being two classes of queens was stated as early as 1856 by Mr. Charles Lespes, in his investigations of *Termes lucifugus* at Bordeaux, France.

Dr. Fritz Müller made a series of observations in Brazil, confirming the general fact, and sent some of his results to Mr. Charles Darwin.

In 1872 Müller published his observations, which were of a longer duration than Lespes, and included species of the three genera we have mentioned. When he speaks of *Eutermes*, I am unable to determine whether he means species with mandibles, or those with beaks. In some details Müller does not agree with Lespes, but confirms the general facts.

Lespes found in the species of *Termes lucifugus* nymphæ of two forms, viz.:

1st. Those with long wing cases.

2nd. Those with short wing cases.

He designated the 1st as nymphæ of the first form, and the 2nd as nymphæ of the second form.

He stated, from the 1st form came the large queens and kings, and from the 2nd form small queens and kings, which are now designated as supplementary. Lespes stated that the winged imagines from the nymphæ would swarm the last of May or the fore part of June.

The nymphæ of the 2nd form would remain in the nest. At the time of the swarming of the imagines from the 1st form, Lespes states that he never saw a winged imago from the nymphæ of the 2nd form, but expects there would be, swarming tak ng place in August or September. The last was merely conjecture, and Müller says, according to his observations, was wrong. He found the wing-cases of the nymphæ of the 2nd form to be only rudimentary, and the imagines from them being wingless remained in the old nest.

The specimens of the nymphæ of the 2nd form, the imago and gravid queens, sent up by Mr. Beaumont, only have rudimentary wing-cases, and could not swarm. Three stages of larvæ and nymphæ have so far been found by Mr. Beaumont of the 2nd form, and he expects to find others. Interesting as this matter is scientifically, it is equally so practically.

Ample provision seems to be made for the dissemination of the inmates of a colony to form new ones, and at the same time fully providing for the perpetuation of the old one, making it very difficult to destroy a well-established colony.

Mr. Beaumont finds many of the nests destroyed by taking out the queen-cell and the queen or queens, were rebuilt in a few months, containing other queens. It will be remembered that in my previous paper I stated, when the galleries leading to and from a nest were destroyed, they were soon rebuilt. The latter will be more readily understood after seeing a lantern view of a nest.

The habits of each of the three genera of Termites, found upon the Isthmus, are so different that remedies, which may be effectual against one genus, may not be so against another, and in order to carry out practical measures, checking their destructiveness, it has become necessary to designate each genus so that ordinary workmen can distinguish them.

In my paper of last year, I stated that *Eutermes*, was made a sub-genus of *Termes*, owing to a peculiar venation of the wing. This means of classification included species having soldiers with mandibles, and species having soldiers with beaks in the same genus. On the Isthmus the venation of the wings is not constant, nor can winged insects be found at all seasons of the year. And authorities do not agree in identification. In my first paper, for the time being, I called all those species with

beaks *Eutermes*. This by no means avoids the confusion in the matter. And further study indicates that the habits of the two genera are so different that I now propose to call all those species having soldiers with beaks *Milesnasitermes*, soldier-nosed-termes.

The workmen know when they break a gallery and find a mandibulate soldier that the nest is likely to be inside of some post or beam near by, unless it should be a species of *Termes columnar*, in which case it is likely to be a mud nest, rising from the ground. These Termites belong to the genus *Termes*. On the other hand, when they break a gallery and find a soldier with a beak, the nest may be a long distance from that point, but it will be on the exterior of the wood, or tree. These Termites belong to the genus *Milesnasitermes*. If the workman does not see any exterior galleries, but finds a few little pellets of wood, on the floor, he knows the *Calotermes* are in the wood. The remedy in each case must be different. These simple designations can be understood by those, who must deal with the subject practically.

Lantern-slide No. 4 shows the representation, nearly full size, of one of the largest nests of *Milesnasitermes* yet found upon the Isthmus. It was in a store-house, and was 10 ft. in height,—greatest width 2½ft., and greatest depth 1½ft., estimated weight 300 lbs. The wood of the building was badly injured, while galleries ran from this to other buildings. One gallery ran to a chapel, and the organ was destroyed.

Slide No. 5 shows a mud nest of *Termes columnar*, at Ceroyal Station of the Panama R.R., on the Pacific slope. It is over 5ft. in diameter on the base, and nearly 4ft. high. It is very strong and readily holds up a man. These mud nests have only been discovered on the Pacific slope. A species quite similar has been found on the Atlantic slope, having a nest in a rotten stump.

Slide No. 6 shows Mr. Beaumont's study at Colon. On the table is his microscope and several of the ash blocks containing Termites for examination. It probably can be noticed that the table legs are in jars of water, which is a common custom on the Isthmus, to keep the Termites and common ants from the table.

On the table are two of Mr. Beaumont's glass termitaria,

each with a colony from the same nest of *Termes columnar.* He had a bridge connecting them, and the inmates built a gallery on it, and passed to and fro. He then took away the bridge, and each colony raised up a vertical gallery; one 11½ inches high, the other 7½ inches. A portion of a large nest of *Termes columnar* is shown on the table, which is cylindrical.

Slide No. 7 shows nests, galleries, queen-cells and one specimen of wood-tunneling by the *Calotermes.* The object of chief interest is a bridge, on which are built two galleries by two different species, which he had in one jar. The nests were side by side, without communication, and when they wished to cross the bridge each built a covered gallery.

It is hardly necessary to state that the beautiful slides of sections of the queen Termites were prepared by Mr. Ludwig Riederer, to whom I am much indebted for his invaluable assistance in the study of the anatomy of the Termites.

SPIRAL, OR ELLIPTICALLY WOUND TRACHEIDS, IN THE AXILLA OF SMALL DECAYED BRANCHES IN TREES.

BY P. H. DUDLEY, C. E.

(*Read January 17th*, 1890.)

The spiral, or elliptically wound tracheids. in the pieces of Yellow Pine, *Pinus palustris*, Mill., and White Cedar, *Chamæcyparis Sphæroidea*, Spach, before you this evening, are evidences of some of the wonderful phenomena, which trees possess during growth, of preserving the integrity of their structures.

I called your attention to these features last year, having noticed them very frequently in the above woods.

Continued work upon the decay of woods the past season leads me to believe, that similarly wound tracheids or fibres will be found in most species of wood grown in dense forests, where, for want of light, the lower branches die, are attacked by fungi, break off, and the stub is overgrown, the entire process constituting a system of natural pruning and protection. The more we study this process the more instructive and marvellous it becomes. For the growing cells of the trunk promptly take

in the situation, and effectually, as a rule, do that which is necessary to protect those already formed from the attacks of the fungi, and build up and carry on the structure of the tree unimpaired.

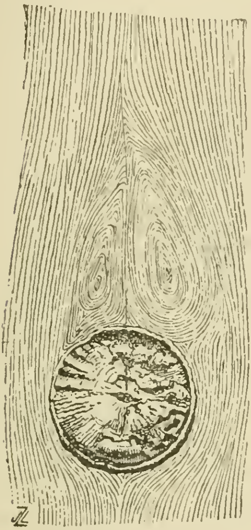

Fig. 1.

It is now well known that it is the function of many of the fungi by growth to undo the structure of the wood, cause it to decay, and reduce it to elements which again can be used by growing trees or plants.

For the growth of fungi, three conditions in combination are essential, viz.: 1st, *Moisture*; 2nd, *Heat*, ranging from 35° to140° Fahr.: 3d, *Air*.

Eliminate any one of these conditions, and the growth of the fungi is checked, the wood not decaying.

To more readily trace the features of the natural system of pruning, and to see how the tree eliminates one of the conditions for the growth of the fungi, it will be well to recall to our minds a few facts regarding the growth of trees. They increase their height, year by year, by successive additions to the length of their leaders or leading branches.

When the lateral branches shoot off from the trunk, their height remains practically the same distance from the ground, as the tree grows. Whether all those branches will continue to develop, or the lower ones die, depends largely upon the amount of light the tree receives. Therefore, if the tree grows in an open field, it will be surrounded by light on all sides, which, acting on the chlorophyll in the leaves, will maintain the vigor and growth of all the branches. The trunk of the tree will be comparatively short, having many lateral branches. In this case, little if any natural pruning has taken place. On the other hand, when trees grow in the dense forests, only the uppermost branches receiving sufficient light for development, the lower ones being shaded, become dwarfed, die and are attacked by fungi. The

process of natural pruning takes place, and as a result those trees have tall branchless trunks, to the head of the tree.

From the above we can understand what is shown to have taken place in the specimens of wood before us.

Fig. 1 is a representative of the tangential section of Yellow Pine, enlarged to 1½ diameters, showing the elliptically wound

FIG. 2.

tracheids, which have formed in the axilla of the dead branch. Fig. 2 shows a portion of the same tracheids, enlarged to 15 diameters.

Figs. 3 and 4 show similarly wound tracheids from the White edar. Fig. 3 is enlarged to 1½ diameters and Fig. 4 to 15 diameters.

As soon as the lower branches die, the tree not only makes strenuous efforts to protect itself from the attacks of fungi

around and through the limb, but also to rid itself of the useless member. The cells of the cambium layer of the branch no longer being active those of the trunk are rolled out, pressing firmly against the lower, right and left sides of the branch, over the upper side, or the *axilla* of the branch, the expanding cambium layer would be separated for a short distance, leaving a triangular, or heart-shaped space. To close up this space is the function of the spiral, or elliptically wound tracheids. At first there is usually but one series ; but as the tree increases in diameter, and the branch is compressed in diameter, a second, and, sometimes, a third series form, as is the case of the White Cedar illustrated.

FIG. 3.

This tree growing in swampy ground, is a slow grower, and a durable wood. It decays slowly, even when attacked by its special fungus, *Agaricus campanella*, Batsch. It takes many years for the wood to grow over the stub of the decayed branch, and in many cases the fungus will work through the stub to the upright cells of the tree, and start a small zone of decay. The increasing spirally wound tracheids check the air supply, eventually cutting it off, eliminating one of the essential conditions in the combination for the growth of the mycelium of the fungus, and further decay of the living tree is arrested.

Timber cut from the White Cedar often shows many zones, where decay has started and has been subsequently arrested. In all cases these zones of decay have been started around the decayed branches, and arrested as described. The mycelium in these zones of decay will remain dormant for years, but will revive if the tree is cut into timber and used, when all of the conditions for the growth of fungi are in combination. Yellow Pine being a more rapid tree to grow than the White Cedar, the stubs of the decayed branches are more quickly overgrown, and we do not find the upright cells of the wood as frequently at-

tacked as in the White Cedar. The mycelium, however, of its special fungus, *Lentinus lepideus*, is frequently found in the overgrown stubs, and, when the wood is used for ties, it revives and fruits. It is very destructive to the wood, when the latter is used in contact with the soil; the resin in the wood furnishing little resistance to its ravages.

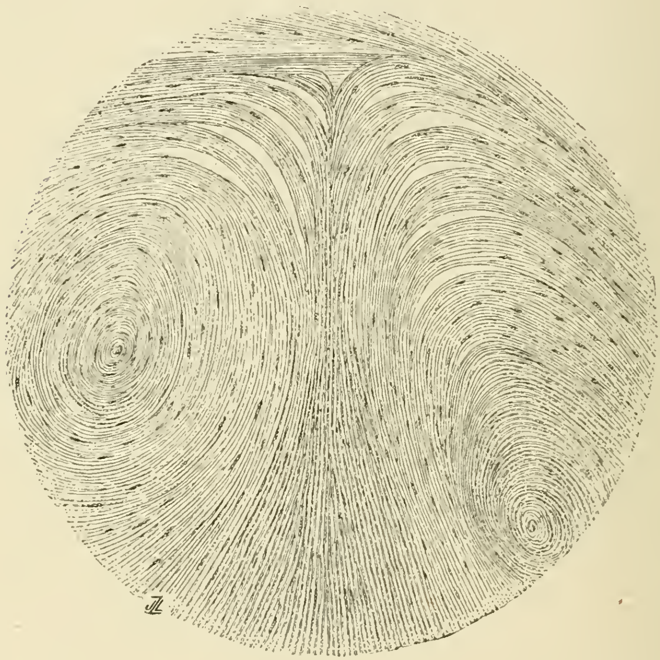

FIG. 4.

The growing trees of Yellow Pine protect the duramen of their trunks from its destruction, by closing up their wounds, shutting off the air supply and breaking the combination of conditions essential to its growth.

From these illustrations a very practical lesson is to be learned, and that is, in pruning trees, we ought to follow nature and protect the wounds, otherwise, if the tree cannot do it, the fungi will attack, and injure the tree.

PROCEEDINGS.

Meeting of April 18th, 1890.

The President, Mr. P. H. Dudley, in the chair.

Thirty-eight persons present.

Mr. L. Riederer read by title a Paper, entitled "Notes on Staining Sections made by the Paraffin-Process enclosed in a film of Collodion." This Paper is published in the present volume of the Journal, p. 88.

The six low-power objectives, announced at the last meeting as purchased for the use of the Society, were placed in the care of the Curator, and the Committee on this matter was discharged.

Dr. Frank D. Skeel exhibited a one-inch objective of his own grinding and mounting, and explained some points of interest in the combination. It is a triplet, the central glass, crown, with a radius of .41 inch, and the two outer glasses, flint, with radii of .80 inch. The combination gives good working distance, plenty of light, and good definition, and would be very useful for dissecting purposes. The skill and success of Dr. Skeel shown in the manufacture of this objective were commended by Mr. William Wales.

The Paper announced on the programme for the evening, and entitled "The Long Island Oyster" was read by Dr. Bashford Dean. This Paper was illustrated by black-board drawings, and by a large collection of interesting specimens. A discussion followed, participated in by Messrs. F. W. Devoe and F. W. Leggett, and Dr. Paul Hoffman.

Meeting of May 2nd, 1890.

The President, Mr. P. H. Dudley, in the chair.

In the absence of the Secretary, Mr. George E. Ashby was elected Secretary *pro tem.*

OBJECTS EXHIBITED.

1. Microscope stand and objectives, used by the late Dr. J. W. Draper in taking photomicrographs, and also specimens of these photomicrographs on daguerreotype plates; loaned for the occasion by his son, Dr. Daniel Draper: by P. H. Dudley.

2. Spiracles of the larva of the Nut-weevil.
3. Spiracles of the Roach.
4. Spiracles of Dragon-fly.
5. Spiracles of the larva of the Hawk-moth.
6. Spiracles of Cicada.
7. Spiracles of Bishop's Mitre.

Nos. 2–7 by F. W. LEGGETT.

8. A Turn-table modified for cutting cells : by FRANK D. SKEEL.

9. Sections of petrified wood from Cairo, Egypt, collected by Dr. H. Carrington Bolton : by T. B. BRIGGS.

10. Section of red Syenite from the Obelisk in Central Park, New York : by T. B. BRIGGS.

11. Spicules and gemmules of Sponge from nest of Termites, prepared by Mr. J. Beaumont, Colon, S. A.: by P. H. DUDLEY.

12. Pond-life ; *Melicerta ringens*, *M. tubicularia*, *Actinosphærium Eichhornii*, *Paludicella Ehrenbergii* (one week old) : by STEPHEN HELM, of 417 Putnam Avenue, Brooklyn, N. Y.

Mr. Dudley explained his exhibit of the stand and objectives used by the late Dr. J. W. Draper, and read an account of the process employed, as described in Dr. Draper's "Scientific Memoirs."

Dr. E. G. Love questioned the claim for Dr. Draper, that he had taken the first photomicrographs, and pointed to the facts that Sir Humphry Davy and Wedgewood in 1802, succeeded in producing photomicrographs by the sun-microscope, which, however, were not permanent ; that Dr. Hodgson in 1840, using the gas-microscope and daguerreotype plates, produced photomicrographs ; and that in France, in 1844, there was published an atlas of photomicrographs ; while Dr. Draper's work was done between 1851 and 1856.

Mr. F. W. Leggett described at length and in an interesting manner his exhibit of spiracles from six orders of insects.

Dr. F. D. Skeel described his modification of the turn-table for cutting cells and accomplishing similar work.

Mr. C. F. Cox said that he naturally felt interested in any modification of this useful accessory to the microscope, but he wished to improve this opportunity to protest against the unnecessary complication and expense, which had been introduced into the self-centering turn-table by manufacturers, since

he first brought it forward in 1875. Nearly all present makers, he believed, employed a coiled spring to move the clutches, and this was either so stiff as to need care to prevent its chipping the slide, or else was not stiff enough to permit of the application of a cutting tool to the cell while upon the table, and most of the arrangements, which had come under his notice, required the use of both hands to place or to release the slide. He felt sure that the right and left screw was altogether the most convenient, effective and economical mechanism for controlling the clutches, and thought the manufacturers would confer a great benefit upon the preparers of specimens if they would return to that original and simple device.

Mr. Stephen Helm, in relation to his exhibit, stated that in England he had never seen a branched *Melicerta*, while here such a form is very common, and seems peculiar to America. He had lately found one specimen with thirty-six branches.

Mr. Dudley explained the sections of petrified wood from Cairo, Egypt, and also the spicules and gemmules of sponge from a Termite's nest from Colon, S. A.

The Secretary announced that the Department of Microscopy of the Brooklyn Institute would hold its Annual Reception on the evening of the 8th inst., and that he had received programmes and tickets of admission for the use of the Society.

On motion it was resolved that the thanks of the Society be hereby tendered the Department of Microscopy of the Brooklyn Institute.

Meeting of May 16th, 1890.

The President, Mr. P. H. Dudley, in the chair.

OBJECTS EXHIBITED.

1. Sections of Chalcedony in agate : by T. B. Briggs.

2. Sections of a Meteorite, which fell May 2nd, 1890, in Iowa : by George F. Kunz.

3. Serial sections of the Brook Trout, two days from the egg : by L. Riederer.

4. *Termes flavipes*, soldier : by P. H. Dudley.

5. *Calotermes milesnasitermes*, soldier : by P. H. Dudley.

6. The same, young, with the beak just developing : by P H. Dudley.

7. *Termes flavipes*, Kollar, worker: by J. L. ZABRISKIE.

8. The same, soldier: by J. L. ZABRISKIE.

9. The same, female, winged and fully developed preparatory to swarming: by J. L. ZABRISKIE.

10. Large cells and tunnels in wood, made by these Termites: by J. L. ZABRISKIE.

Dr. Dean explained, with black-board drawings, the remarkable points of Mr. Riederer's serial sections of the Brook Trout.

Mr. Dudley explained, with black-board drawings, the method of growth and repair of the beaks and mandibles of *Calotermes milesnasitermes*, and also read a communication from Mr. J. Beaumont, of Colon, S. A., a Corresponding Member of the Society, on the swarming of the Termites of that locality.

Mr. Zabriskie said of his exhibit: These are specimens of our only native species of Termite, and they are all taken from one colony, found, on the 10th of the present month, in a piece of White Pine plank lying on the ground, at the Water Works, Flatbush, Long Island. The region is so frequented by entomologists that nearly every available piece of wood lying upon the ground is turned, about once in every twenty-four hours, in search of prey. But this piece of plank happened to be concealed in a clump of shrubbery, and had probably lain undisturbed for a long time. The colony was strong in numbers, and the tunnels and cells excavated in the wood were unusually large. One of the cells here exhibited measures ½ × 1 inch in diameter, and three inches in length.

Colonies are abundant in this locality in decaying stumps, pieces of board, or in any other wood lying for any considerable time upon the ground. During this present season the first observed males and females with wing-pads were found in a decaying stump on April 19th. On May 7th, in another stump were found males and females further advanced, some still with wing-pads, but others with thoracic and abdominal rings becoming darkened, and with full-sized wings, although the wings of all were still ivory white. It will be observed that the female here exhibited, taken on May 10th, has the color of full development—head and rings nearly black, and wings transparent with dark veins. After the early days of June no winged specimens were found.

The following donations to the Library were made by Mr.

William G. DeWitt : Hand-Book of Invertebrate Zoology, W. K. Brooks ; Guide to the Microscope in Botany, Behrens ; The Microscope, vols. vi-ix ; Journal of the Postal Microscopical Club, 1882-1889.

Meeting of June 6th, 1890.

The Vice-President, Mr. J. D. Hyatt, in the chair.

Fifteen persons present.

On motion the New York Mineralogical Club was invited to hold a joint meeting with this Society at the rooms of the latter on June 20th.

The Secretary read a Paper by Mr. George F. Kunz on the Meteorite recently fallen in Winnebago County, Iowa. Specimens of this were exhibited and commented on by Mr. T. B. Briggs.

The Secretary read a letter from Mr. J. Beaumont of Colon, S. A., upon the swarming of the White Ants, *Termes testaceus*.

Meeting of June 20th, 1890.

The Vice-President, Mr. J. D. Hyatt, in the chair.

Forty-four persons present.

In the absence of the Secretary, Mr. Anthony Woodard was elected Secretary *pro tem.*

Mr. Charles S. Shultz, of the Board of Managers, made a statement of the proposed change of the place of meeting, from the present rooms to the first floor of the same building.

The joint meeting of the New York Mineralogical Club and the Society was addressed by the Rev. G. G. Rakestraw, of Philadelphia, on "Microscopical methods in Mineralogy, with especial reference to the mounting of opaque objects."

The Address was illustrated by a large number of beautiful and valuable specimens, as announced below, from the collection of the speaker.

OBJECTS EXHIBITED.

From the collection of the Rev. G. G. Rakestraw.

Native copper, chrysocolla, cuprite, azurite, hydrocuprite, malachite, native copper and cuprite, aragonite and selenite, Cornwall, Penn.

Copper ores from Utah, Colorado and Arizona, consisting of brochantite, clinoclasite, tyrolite, olivenite, conichalcite, cuprite, azurite and malachite.

Descloizite and brown vanadinite from New Mexico.

Vanadinite in a variety of forms from Arizona. Vanadinite in calcite, Collateral mines, Arizona.

Pharmacosiderite, scorodite and jarosite from Utah.

Lettsomite from Arizona. Lanthanite from Saucon Valley, Pennsylvania.

FOREIGN MINERALS.

Green garnets, Orford, Quebec, Canada.

Aurichalcite, Atacamite and Proustite: Chili.

Celestite, Sicily. Hematite crystallized from England.

Hematite crystals with double terminated quartz crystals on the sharp ages of the hematite, England.

Percylite, South Africa. Herrengrundite from Herrengrund, Hungary.

Pucherite, Saxony. Eleonorite, Prussia. Liroconite and Torbernite from Cornwall, England. Gothite in quartz. Variety of Pyrrhosiderite, Prussia, etc.

Also a large series of fine mounted minerals loaned by Mr. George W. Fiske, of Philadelphia, Pa.

On motion the thanks of the joint meeting were tendered the Rev. G. G. Rakestraw for this Address and exhibition.

Vice-President Hyatt announced the next meeting of the American Society of Microscopists, to be held at Detroit, Michigan, on August 13th, 1890.

On motion the Society adjourned until the first Friday of October next.

PUBLICATIONS RECEIVED.

The Microscope: Vol. X., Nos. 6–8 (June–August, 1890).

The American Monthly Microscopical Journal: Vol. XI., Nos. 6–8 (June–August, 1890).

The San Francisco Microscopical Society: Proceedings (June 4–September 17, 1890).

The Botanical Gazette: Vol. XV., Nos. 6–9 (June–September, 1890).

Bulletin of the Torrey Botanical Club: Vol. XVII., Nos. 6–9 (June–September, 1890).

Insect Life: Vol. II., No. 11—Vol. III., No. 1 (May–August, 1890).

Psyche: Vol. V., Nos. 170, 171 (June, July, 1890).

Entomologica Americana: Vol. VI., Nos. 7–9 (July–September, 1890).

The School of Mines Quarterly: Vol. XI., No. 4 (July, 1890).

Anthony's Photographic Bulletin: Vol. XXI., Nos. 11–18 (June 14–September 17, 1890).

The Natural Science Association of Staten Island: Proceedings (June 12–September 11, 1890).

Academy of Natural Sciences of Philadelphia: Proceedings, Part 1. (January–March, 1890).

American Academy of Arts and Sciences: Proceedings, Vol. XXIV. (1889).

Cornell University College of Agriculture: Bulletins Nos. 17–19 (May–August, 1890).

Kansas Experiment Station: Second Annual Report (1889).

Transactions of the Kansas Academy of Science: Vol. XII., Part 1 (1889).

Experiment Station of Alabama: Bulletins Nos. 16–17 (June, July, 1890).

Experiment Station of Michigan: Bulletins Nos. 63, 64 (July, 1890).

Michigan Board of Agriculture: Report (1889).

The West American Scientist: Vol. VII., Nos. 50–52 (June–August, 1890).

Crystallogenesis: by Dr. H. Hensoldt (May, 1890).

United States Geological Survey: 8th Annual Report (1886, 1887).

The Brooklyn Medical Journal: Vol. IV., Nos. 7–9 (July–September, 1890).

Indiana Medical Journal: Vol. VIII., No. 12—Vol. IX., No. 3 (June–September, 1890).

The Satellite: Vol. III., No. 10—Vol. IV., No. 1 (June–September, 1890).

The Hahnemannian Monthly: Vol. XXV., Nos. 7–9 (July–September, 1890).

Johns Hopkins University Circulars: Vol. IX., No. 82 (June, 1890).

The Pacific Record of Medicine and Surgery: Vol. V., No. 1 (August, 1890).

The American Lancet: Vol. XIV., Nos. 6–9 (June–September, 1890).

The Electrical Engineer: Vol. IX., No. 110—Vol. X., No. 125 (June 11–September 24, 1890).

National Druggist: Vol. XVI., No. 12—Vol. XVII., No. 6 (June 15–September 15, 1890).

Mining and Scientific Review: Vol. XXIV., No. 24—Vol. XXV., No. 12 (June 12–September 18, 1890).

Journal of the Royal Microscopical Society: Parts 3, 4 (June, August, 1890).

Journal of Microscopy and Natural Science: Vol. III., No. 3 (July, 1890).

The Journal of the Quekett Microscopical Club: Vol. IV., No. 27 (July, 1890).

Grevillea: Nos. 88, 89 (June, September, 1890).

The Naturalist: Nos. 180–182 (July–September, 1890).

Nottingham Naturalist's Society: Transactions and Report (1889).

North Staffordshire Naturalist's Field Club: Transactions and Report (1890).

Natural History Society of Glasgow: Proceedings and Transactions, Vol. II., Part 2—Vol. III., Part 1 (1887–1889).

The Ottawa Naturalist: Vol. IV., Nos. 4–6 (July–September, 1890).

Proceedings of the Canadian Institute: Vol. XXV., No. 153 (April, 1890).

The Canadian Record of Science: Vol. IV., No. 3 (July, 1890).

The Victorian Naturalist: Vol. VI., No. 12—Vol. VII., No. 1 (April, May, 1890).

Société Royale de Botanique de Belgique: Comptes-Rendus (June 22, 1890). General Index (1890).

Monatsblätter des wissenschaftlichen Club in Wien: Vol. XI., Nos. 9–11 (June–August, 1890).

Bulletin de la Société Belge de Microscopie: Vol. XVI., No. 7 (April, 1890).

Sitzungsberichte der Gesellschaft der gesammten Naturwissenschaften zu Marburg (1889).

Bulletin de la Société d'Études Scientifiques d'Angers (1885–1889).

Memoires de la Société Nationale des Sciences Naturelles de Cherbourg Vol. XXVI. (1889).

Nuovo Giornale Botanico Italiano: Vol. XXII., No. 3 (July, 1890).

Notarisia Commentarium Phycologicum: Vol. V., No. 19 (June, 1890).

Académie d'Hippone: Proceedings (December, 1889).

Société des Naturalistes de Kiew: Proceedings, Vol. X., No. 3—Vol. XI., No. 1 (1890).

Société Impériale des Naturalistes de Moscou: Bulletin, 1889, No. 3; Meteorologische Beobachtungen, Vol. III., No. 2 (1889).